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SEMI -AUTOMATIC
WEB-LINE FEASIBILITY STUDY

U.S. Department of Transportation
Maritime Administration

in cooperation with
Avondale Shipyards: New Orleans, Louisiana

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FOREWORD

A SEMI-AUTOMATIC WEB LINE SYSTEM IS REPORTED ON HERE. IT OFFERS COST-SAVING FEATURES AND PRACTICAL BENEFITS TO SHIPYARDS. INCREASED PRODUCTIVITY IS THE GOAL AND PURPOSE OF THE SEMI-AUTOMATIC WEB LINE (SAWL) SYSTEM. THE PLAN IS IN PART, A RESPONSE TO AN INDUSTRY PRIORITY SET FORTH BY THE MERCHANT MARINE ACT OF 1970: TO IMPROVE SHIPBUILDING PRODUCTIVITY AND REDUCE SHIPBUILDING COSTS WHILE MAINTAINING HIGH STANDARDS FOR CRITICAL OPERATIONS.

IT IS ANTICIPATED THAT THE RESULT OF THIS PRELIMINARY EXAMINATION WILL DEMONSTRATE TO THE SHIPBUILDING INDUSTRY, THROUGH THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS (SNAME) FACILITIES PANEL SP-1, THE MARITIME ADMINISTRATION AND THE U.S. NAVY, THAT THE DEVELOPMENT AND IMPLEMENTATION OF THE SEMI-AUTOMATIC WEB LINE PLAN AS RECOMMENDED FILLS ALL CRITERIA FOR COOPERATIVE PROGRAM CONTINUATION AS DEFINED BY THE NATIONAL SHIPBUILDING RESEARCH PROGRAM. THE IMPORTANCE OF THIS PROJECT WOULD BE EVEN FURTHER EMPHASIZED BY A FULL ROSTER OF ALL WHO GAVE TIME AND KNOWLEDGE TO AID THE RESEARCH AND PLANNING. NUMEROUS INDIVIDUALS ARE DUE CREDIT AND THANKS, FOR BOTH SIGNIFICANT CONTRIBUTION, AND AN ONGOING INVOLVEMENT WITH THE PROJECT'S CONCEPT, PLANNING, PROGRESS, AND POSITIVE RESULTS.

THIS REPORT EVOLVED AS ONE OF MANY PROJECTS UNDER THE AUSPICES OF THE NATIONAL SHIPBUILDING RESEARCH PROGRAM. THE PROGRAM IS A COOPERATIVE EFFORT BETWEEN THE MARITIME ADMINISTRATION'S OFFICE OF ADVANCED SHIP DEVELOPMENT AND THE U.S. SHIPBUILDING INDUSTRY.

ON BEHALF OF AVONDALE SHIPYARDS, INC., MR. RICHARD A. PRICE WAS THE PROGRAM MANAGER RESPONSIBLE FOR TECHNICAL DIRECTION AND PUBLICATION OF THE FINAL REPORT. PROGRAM DEFINITION AND GUIDANCE WERE PROVIDED BY THE MEMBERS OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS SHIP PRODUCTION COMMITTEE, PANEL SP-1, SHIPYARD FACILITIES AND ENVIRONMENTAL EFFECTS. MR. G. WILKENS, PRESIDENT OF OXYTECHNIK, FUNCTIONED AS PROJECT MANAGER. THE FINAL REPORT WAS EDITED BY MR. HARRY L. TABONY OF SPACE SYSTEMS, INC.

EXECUTIVE SUMMARY

OBJECTIVE

THE PRIMARY REJECTIVE OF THIS PROJECT WAS TO DESIGN A COST-EFFECTIVE SEMI-AUTOMATIC METHOD OF PRE-FABRICATION, FABRICATION AND ASSEMBLY OF WEB SECTIONS, KNOWN AS A SEMI-AUTOMATIC WEB LINE (SAWL). THE GOAL WAS TO REDUCE MATERIAL HANDLING, FITTING AND WELDING LABOR, AND AT THE SAME TIME BRING ABOUT IMPROVED FLOW EFFICIENCY, SPACE UTILIZATION, AND INTEGRATION WITH OTHER ADVANCED MANUFACTURING PRACTICES AND SCHEDULING.

APPROACH

A TECHNICAL APPROACH WAS TO DEVISE SEVERAL SYSTEMS, FIVE IN THIS CASE, AND THEN TO ADOPT THE ONE WHICH MOST SUITED THE DESIGN CRITERIA, WHILE AT THE SAME TIME BEING COST-EFFECTIVE. THE FIVE POSSIBLE SOLUTION STUDIES ARE LATER DESCRIBED AS PLAN A, B, C, D, AND E. PLAN A WAS CHOSEN AS THE TEST CASE BECAUSE IT MEETS ALL OF THE DESIGN CRITERIA, . IT CAN BE IMPLEMENTED TODAY, IT IS PRACTICAL, WORKABLE, FEASIBLE, AND OFFERS MEASURABLE TANGIBLE BENEFITS.

CRITERIA

THE FOLLOWING LIST OF FUNCTIONS DESCRIBES THE SEMI-AUTOMATIC WEB LINE (SAWL). THE COMPONENTS CAN BE CONSIDERED FOR USE INDIVIDUALLY OR IN VARIOUS COMBINATIONS RESULTING IN THE ENTIRE SYSTEM.

FUNCTIONS

ORIENTATION:

A MEANS WAS DESIGNED SO AS TO ORIENT EACH WORK PIECE SO THAT AUTOMATIC CUTTING AND/OR POSITIONING AND WELDING OF COMPONENT PIECES COULD BE ACCOMPLISHED.

MARKING:

ONCE ORIENTED, EACH WORK PIECE CAN BE MARKED FOR BEAM PLACEMENTS AND NUMERICALLY IDENTIFIED FOR DELIVERY TO THE SUBSEQUENT PROCESSING LANE.

CONVEYING:

A MEANS OF CONVEYING THE WORK PIECES TO THE AUTOMATIC AND SEMI-AUTOMATIC WORK STATIONS WAS DESIGNED, SO AS TO MAINTAIN THE ORIGINAL ORIENTATION. (IN ONE PROPOSAL THE WORK PIECE IS STATIONARY AND THE MACHINES MOVE TO IT.)

SURFACE PREPARATION:

A SEPARATE, BUT INTEGRATED SEMI-AUTOMATIC WORK STATION WAS DESIGNED TO SHOT BLAST THE SURFACE EDGES OF BEAMS AND STIFFENERS JUST PRIOR TO WELDING THEM ONTO THE-WEB PLATES.

INCLUDED IN THE EDGE PREPARATION WORK STATION IS A SYSTEM FOR SORTING AND PLACING EACH BEAM ONTO A SPECIAL PALLET FOR FEEDING THE AUTOMATIC BEAM POSITIONING AND WELDING MACHINE.

POSITIONING AND WELDING:

BEAMS LONGER THAN 3 FT. UP TO 13 FT. ARE FED TO THE AUTOMATIC POSITIONING AND WELDING MACHINE WHICH IS CAPABLE OF PERFORMING THE ENTIRE OPERATION (WITH SOME MINOR WELDING BEING FINISHED MANUALLY, LATER), PROVIDED THE BEAMS AND THEIR LOCATIONS FALL WITHIN THE CAPABILITIES OF THE MACHINE. (SEE SECTION 2.19, FIGURE 1 AND 2.) SHORTER SEAMS, AND SOME SPECIAL BEAMS AND BRACKETS ARE POSITIONED AND WELDED MANUALLY WITH AN OPERATOR-ASSISTED WORK POSITIONER.

TRANSPORTATION AND HANDLING:

A MEANS OF IN-PROCESS HANDLING AND DELIVERY TO THE SUBSEQUENT WORK PROCESS LANES IS PROVIDED UTILIZING PREVIOUSLY DESIGNED EQUIPMENT.

COMPUTER SOFTWARE:

THE COMPUTER AND SOFTWARE IS STAND-ALONE AND CAPABLE OF PERFORMING ALL NECESSARY FUNCTIONS, AND OF BEING CONTROLLED INDEPENDENTLY, OR BY A HOST COMPUTER.

COSTS:

THE COST OF THIS SEMI-AUTOMATIC WEB LINE (SAWL) IS ESTIMATED AT APPROXIMATELY 2,500,000 DOLLARS; THE ESTIMATED ROI IS 54.6 PERCENT. WITH A PAYBACK IN APPROXIMATELY 2.65 YEARS. THE

PLANT IS DESIGNED TO PRODUCE WEBS AT APPROXIMATELY 5 TONS PER HOUR, OR 16,000 TONS PER YEAR, WORKING TWO SHIFTS. MANPOWER PROJECTIONS OF WEB PRODUCTION IS ESTIMATED AT APPROXIMATELY 93,818 MAN-HOURS WITHOUT THIS SEMI-AUTOMATIC WEB LINE, AND APPROXIMATELY 24,954 MAN-HOURS WITH IT; A SAVINGS OF 68,864 MAN-HOURS PER YEAR, OR 73.4 PERCENT!

EXPANSION:

THE SYSTEM'S PRODUCTIVE CAPACITY CAN BE INCREASED, WITHOUT ADDING A THIRD SHIFT, BY INSTALLING PRESENTLY AVAILABLE ADDITIONAL WELDING AND ROBOTIC TECHNOLOGY.

SECTION ONE

SEMI-AUTOMATIC WEB LINE SYSTEM - FEASIBILITY GUIDELINES

1.1 TECHNICAL APPROACH

THE INTENT OF THIS STUDY: TO EXAMINE THE FEASIBILITY OF A NEW WEB-LINE PLAN FOR SHIPYARDS, DESIGNED TO INCORPORATE CURRENT STATE-OF-THE-ART MANUFACTURING PROCESSES WHICH OFFER BOTH TECHNOLOGICAL INNOVATION, HIGH FUNCTIONAL RELIABILITY, AND INTEGRATION INTO THE LATEST OTHER MANUFACTURING AND ASSEMBLY TECHNIQUES ALREADY BEING EMPLOYED. OUR TECHNICAL APPROACH COVERED THE FOLLOWING:

- LAYOUT OF FACILITIES WAS DRAWN TO SHOW WORK STATIONS, EQUIPMENT LOCATIONS, CONVEYING SYSTEMS, ROUTING, AND OTHER INFORMATION.
- FUNCTIONAL FLOW PROCESSES WERE IDENTIFIED, INCLUDING WORK PIECE ORIENTATION, BURNING, BEAM POSITIONING AND WELDING, AND FINISHING PROCESSES.
- A PRELIMINARY EQUIPMENT LIST WAS DRAWN UP.
- INTERFACE WITH THE SHIP PRODUCTION PROGRAM WAS MAINTAINED.
- NEW SYSTEM COST ESTIMATES FOR THE SAWL PLAN WERE PREPARED.
- PRESENT SYSTEM WAS COMPARED TO THE SAWL PLAN.
- A PHASE ONE COMPLETION REPORT (NOTE-THIS DOCUMENT) WAS PREPARED AND FORWARDED TO MARAD AND THE SHIP PRODUCTION COMMITTEE FOR REVIEW.

1.2 GENERAL PROCEDURES

TO DISCOVER-CURRENT STATE-OF-THE-ART, OUR METHODS INCLUDED INTERVIEWS WITH KNOWLEDGEABLE Individuals IN shipbuilding AND OTHER INDUSTRIES (FOREIGN AND DOMESTIC), REVIEW OF RELEVANT LITERATURE, AND REQUIRED CORRESPONDENCE.

TO IDENTIFY POTENTIAL PARTICIPANTS, WE BEGAN WITH RECOMMENDATIONS OF VARIOUS INDUSTRY AND PROFESSIONAL CONTACTS. SINCE IT WAS NECESSARY TO DETERMINE PRIORITIES WITHIN THIS PROJECT, WE DID SO BASED ON THE LIKELIHOOD OF INCREASED PRODUCTIVITY, OR ECONOMIC GAIN. "

PROPOSAL SUBMISSIONS WERE INVITED FROM VARIOUS MANUFACTURING AND CONSULTING FIRMS AS WELL AS FROM WITHIN THE SHIPBUILDING INDUSTRY ITSELF, AND FROM OTHER BUSINESSES. THAT-SHARE INTERESTS AND CONCERNS WITH THE SHIPBUILDERS. RESPONSES TO INQUIRIES WERE TABULATED, BY GROUP, PRIOR TO IDENTIFICATION OF CANDIDATES JUDGED TO BE BEST QUALIFIED, AND/OR MOST PROMISING, AS PROJECT PARTICIPANTS.

IN EVALUATING PROPOSALS, - OUR PREVIOUS CRITERION CONTINUED TO BE PROMINENT; PRIMARY ATTENTION WAS GIVEN A PROPOSAL'S POTENTIAL FOR ECONOMIC BENEFIT.

RESEARCH DATA WAS PERIODICALLY EVALUATED, AND REPORTS ON PROJECT DATA DISSEMINATED ON AN ONGOING BASIS. SOME INTERIM REPORTS, DELIVERED ORALLY, GAVE INFORMAL PROGRESS REPORTS; THESE INFORMAL REPORTS WERE SUPPLEMENTED AT INTERVALS BY MORE FORMAL, WRITTEN REPORTS AND SUMMARIES:

PRESENTLY, OUR PROJECT DATA HAS BEEN SUMMARIZED, AND ORAL AND WRITTEN REPORTS OF PROJECT RESULTS VARIOUSLY DISTRIBUTED. ADDITIONALLY, AREAS RELATED TO THIS PROJECT, AND OFFERING POTENTIAL OF BENEFIT TO INDUSTRY GOALS, ARE BEING EVALUATED.

1.3 RESEARCH FINDINGS

THERE EXISTS NO SEMI-AUTOMATIC WEB LINE (SAWL) THAT MEETS ALL CRITERIA OF THIS PROJECT. AN AUTOMATIC SEAM POSITIONING AND WELDING MACHINE HAS NOT YET BEEN BUILT, BUT TO DO SO IS ENTIRELY FEASIBLE WITH CURRENT TECHNOLOGY.

MANY RESOURCES (EQUIPMENT, MACHINERY, DEVICES) TO IMPLEMENT SAWL ARE AVAILABLE ON WORLD MARKETS. THE TASK OF MODIFYING OTHERS REMAINS, ALONG WITH THE NEED TO DEVELOP PROTOTYPE EQUIPMENT IN STILL OTHER INSTANCES. AFTER STUDYING-FIVE ALTERNATE PLANS, PLAN A WAS SELECTED AS THE ONE BEST MEETING THE DESIGN CRITERIA; HOWEVER, EACH OF THE FIVE PLANS ARE FEASIBLE AND SOME MAY HAVE MORE MERIT THAN PLAN A UNDER DIFFERENT SETS OF CIRCUMSTANCES .

1.4 FEASIBILITY DETERMINANTS

FEASIBILITY DETERMINANTS OF THE SEMI-AUTOMATIC WEB LINE SYSTEM INVESTIGATED BY THIS PROJECT INCLUDE:

PROCESS: DETERMINE THE DESIGN OF A COST-EFFECTIVE METHOD OF MARKING, BURNING, CONVEYING, WELDING AND POSITIONING COMPONENTS. DETERMINE THE PARAMETERS OF SHAPES AND SIZES THAT CAN BE EFFECTIVELY HANDLED, MANIPULATED AND WELDED.

CRITERIA: THE FACILITY MUST BE DESIGNED TO HANDLE WEBS HAVING A LENGTH UP TO 54 FT. AND A WIDTH OF UP TO 13 FT. , VARYING IN THICKNESS OF 5-1/6TH IN. TO 1 IN. IT ALSO MUST BE CAPABLE OF AUTOMATIC POSITIONING AND WELDING OF BEAMS FROM 1 FT. TO 13 FT. LONG, BY 4 IN. TO 18 IN. WIDE, HAVING A WEB THICKNESS OF FROM 1/4 IN. TO 1 IN. AND SHAPES AS FOLLOWS:

FLAT BEAMS

T - BEAMS

L - BEAMS

BULB- BEAMS

BUILT-UP BEAMS

THE SYSTEM MUST BE FLEXIBLE, WITH THE CAPABILITY OF INSTALLING SPECIAL LOW-VOLUME, NON-STANDARD COMPONENTS. THESE -COMPONENTS COULD BE LARGER OR SMALLER, OR OF A CONFIGURATION OR ORIENTATION THAT FALLS OUTSIDE OF THE AUTOMATIC EQUIPMENT'S DESIGN CAPABILITIES. SUCH COMPONENTS SHOULD BE PROCESSED MANUALLY BUT WITH THE AID OF SEMI -AUTOMATIC HANDLING EQUIPMENT.

SPECIFICATIONS: FOLLOWING IS A LIST OF FUNCTIONAL FEATURES THAT ARE NEEDED AS PART OF AN EFFICIENT, HIGHLY PRODUCTIVE SAWL FACILITY:

- MANUAL FEED SYSTEM FOR ORIENTATION OF WORK PIECES
- AUTOMATIC FEED SYSTEM FOR SORTING, POSITIONING, AND WELDING OF BEAMS AND STIFFENERS ON WEBS
- AUTOMATIC CONVEYING SYSTEM FOR MOVING THE WORK PIECE FROM ONE WORK STATION TO ANOTHER STATION AND MOVING THE COMPONENTS TO BE ADDED ON.
- AUTOMATIC BURNING SYSTEM
- AUTOMATIC MARKING SYSTEM
- MANIPULATOR FIXTURES FOR POSITIONING AND HOLDING COMPONENTS FOR WELDING THAT FALL OUTSIDE OF THE SIZES AND SHAPES THAT CAN BE AUTOMATICALLY INSTALLED.
- AUTOMATIC SURFACE PREPARATION SYSTEM FOR BEAMS.
- AUTOMATIC OR SEMI-AUTOMATIC CONTROL OF TEMPORARY STORAGE AND PALLETIZING SYSTEMS.
- TRANSPORT SYSTEM FOR MOVING . RAW MATERIAL AND FINISHED WEBS.
- SOFTWARE AND STAND-ALONE HARDWARE PACKAGE TO SUPPORT .THE NEW SAWL SYSTEM.

FEASIBILITY DETERMINANTS - REVIEW AND ASSESSMENT: IT WAS DETERMINED THAT THE CRITERIA ARE SOUND. THE CRITERIA AS OUTLINED CAN MEAN IMPROVED PRODUCTIVITY-FOR THE INDUSTRY, ALTHOUGH THERE WOULD BE SOME EXPECTED DIFFERENCES BETWEEN MAJOR SHIPYARDS AND SMALLER FACILITIES, IN IMPLEMENTING COMPONENTS OF THE NEW SYSTEM. PRESENTLY, A NUMBER OF

ITEMS OF EQUIPMENT REQUIRED BY PROJECT CRITERIA ARE AVAILABLE ON TODAY'S WORLD MARKETS, BUT MUST BE DESIGNED INTO A SYSTEM. OTHER ITEMS CAN BE OBTAINED, BUT REQUIRE SOME MODIFICATION TO BE AN OPERATING PART OF THE PRODUCTION PLAN. STILL OTHER ITEMS REQUIRED BY PROJECT CRITERIA DO NOT EXIST AS COMMODITIES AVAILABLE ON TODAY'S MARKET. WHILE THEIR FEASIBILITY CAN BE DETERMINED AND PROJECTED, THESE-MUST BE DEVELOPED AND TESTED BEFORE THEY CAN BE REALISTICALLY SEEN AS PRODUCTION EQUIPMENT FOR THE SAWL SYSTEM.

1.5 FEASIBILITY PERSPECTIVES

TO BE ACCURATE IN DETERMINING IF AN OVERALL SYSTEM IS FEASIBLE, IT IS NECESSARY TO EXAMINE EACH OF THAT SYSTEM'S CRITICAL PARTS OR COMPONENTS. THAT IS WHY, IN THE NEXT PARTS OF THIS SECTION, THE EMERGING "GENERAL PICTURE" OF SAWL FEASIBILITY IS BROKEN DOWN INTO "CLOSE-UPS":

1.5.1 WORK STATION FEASIBILITY

CRITERIA: WORK STATIONS SHOULD BE CONNECTED BY A CONVEYING SYSTEM THAT WILL AUTOMATICALLY MOVE THE WORK PIECE FROM ONE WORK STATION TO ANOTHER, AND MAINTAIN THE ORIGINAL ORIENTATION. THIS AUTOMATIC CONVEYING SYSTEM MUST BE DEVELOPED. EACH WORK STATION ALSO REQUIRES AUTOMATIC OR SEMI-AUTOMATIC POSITIONING CAPABILITY OF COMPONENTS AND MUST BE EQUIPPED WITH APPROPRIATE CONTROLS TO PROCESS THE WORK AT HAND.

RESEARCH CONCLUSIONS: A CONVEYER SYSTEM SUITABLE IN DESIGN FOR TRANSPORTING THE WORK PIECES IS SPECIAL BUT READILY AVAILABLE FROM DOMESTIC AND FOREIGN SUPPLIERS. (SOME SPECIAL LOADING AND UNLOADING DEVICES MUST BE-DESIGNED TO FEED THE SYSTEM; HOWEVER AUTOMATIC AND/OR PUSH-BUTTON CONTROLS ARE AVAILABLE FOR PURCHASE AS STOCK ITEMS). THE ENGINEERING REQUIREMENTS FOR PROPER FEEDING, POSITIONING, AND WELDING, HOWEVER, MUST BE DEVELOPED TO SUIT THE PARTICULAR SYSTEM BEING INSTALLED. IT IS POSSIBLE TO PURCHASE THE CONVEYING EQUIPMENT, LOADING AND UNLOADING DEVICES, POSITIONING AND WELDING EQUIPMENT, AND THE CONTROLS, AS A PACKAGE. THE USER MUST DETERMINE, HOWEVER, THE TYPE AND SIZE OF COMPONENTS NEEDED FOR PARTICULAR REQUIREMENTS.

FEASIBILITY: OUR RESEARCH STRONGLY SUPPORTS THE FEASIBILITY OF THE SAWL SYSTEM HERE OUTLINED AND RECOMMENDED. SOME OF THE HANDLING EQUIPMENT AND DEVICES CAN BE PURCHASED; THE BALANCE MUST BE DESIGNED. PROTOTYPES MUST BE DEVELOPED AND TESTED.

1.5.2 MARKING SYSTEM FEASIBILITY

CRITERIA: MARKING SYSTEM CAPABILITY MUST INCLUDE LOCATING THE EXACT POSITION OF EACH BEAM OR BRACKET TO BE ATTACHED, AND NUMERICALLY IDENTIFYING EACH WEB.

FEASIBILITY: AUTOMATIC MEASURING AND MARKING SYSTEMS CAN BE PURCHASED FOR THIS REQUIREMENT FROM DOMESTIC AND FOREIGN SUPPLIERS.

1.5.3 BEAMS SURFACE PREPARATION FEASIBILITY

CRITERIA: WELDING QUALITY AND SPEED IS A MAJOR CONSIDERATION WHICH IS AFFECTED BY THE CONDITION AND COATING ON THE PIECES BEING WELDED. To ENHANCE QUALITY AND WELDING SPEED THE SURFACE AREA OF BEAMS. TO BE WELDED MUST BE CLEANED.

RESEARCH CONCLUSION: IT WAS DETERMINED THAT THIS PROCESS IS CRITICAL TO THE SYSTEM AND SHOULD BE ACCOMPLISHED IN A SEPARATE STAND-ALONE MACHINE OUTSIDE OF THE MAIN PRODUCTION LINE, AND THAT BEAMS SHOULD BE PROCESSED. IN ORDER OF REQUIRED USE SO AS TO FLOW INTO THE MAIN LINE.

FEASIBILITY: OUR RESEARCH HAS DETERMINED THAT THE NECESSARY COMPONENTS REQUIRED FOR THIS STATION ARE READILY AVAILABLE. .

1.5.4 AUTOMATIC BEAM POSITIONING AND WELDING FEASIBILITY

CRITERIA: THE AUTOMATIC BEAM POSITIONING AND WELDING MACHINE IS THE MOST CRITICAL COMPONENT OF THE SYSTEM RELATIVE TO PRODUCTIVITY. IT MUST BE CAPABLE OF AUTOMATICALLY SELECTING, POSITIONING, AND HOLDING BEAMS, AND THEN AUTOMATICALLY WELDING THEM. THE CONTROLS MUST HAVE MANUAL OVERRIDE SO THAT OPERATORS CAN MAKE MINOR POSITION. ADJUSTMENTS AND/OR CHANGES WHEN NECESSARY. THE IN-FEED MUST BE SUCH THAT THE BEAMS TO BE INSTALLED CAN BE PICKED UP FROM A KNOWN POSITION RELATIVE TO THE ORIENTATION OF THE WEB PLATE.

RESEARCH CONCLUSIONS: NO SUCH EQUIPMENT NOW EXISTS, BUT THE TECHNOLOGY AND HARDWARE NECESSARY FOR THIS MACHINE CAN BE PERFECTED AND PURCHASED.

FEASIBILITY: ALTHOUGH THIS MACHINE MUST BE-DESIGNED AND TESTED, IT IS NOW FEASIBLE.

1.5.5 BEAM FEED FEASIBILITY

CRITERIA: THE FEEDING OF BEAMS TO THE AUTOMATIC BEAM POSITIONING AND WELDING MACHINE IS CRITICAL AS TO SEQUENCE, POSITION, AND ORIENTATION OF THE BEAMS.

RESEARCH CONCLUSIONS: EQUIPMENT REQUIRED FOR THIS OPERATION DOES NOT YET EXIST AND WILL REQUIRE DESIGN AND TESTING.

FEASIBILITY: OUR RESEARCH HAS DETERMINED THAT THE DESIGN OF EQUIPMENT FOR THIS COMPONENT IS FEASIBLE. SIMILAR DESIGNS AND EQUIPMENT EXIST THAT CAN BE UTILIZED, WITH MODIFICATIONS, TO ADAPT TO THIS REQUIREMENT.

1.5.6 MANUAL INSTALLATION FEASIBILITY

CRITERIA: SINCE EVERY SIZE AND SHAPE OF BEAMS AND OTHER ITEMS CANNOT BE AUTOMATICALLY POSITIONED AND WELDED, PROVISIONS MUST BE MADE FOR MANUAL INSTALLATIONS.

RESEARCH CONCLUSIONS: THE QUANTITY OF MANUAL WORK REQUIRED, ALTHOUGH SUBSTANTIAL, IS NOT GREAT ENOUGH TO RENDER THE SYSTEM UNATTRACTIVE FROM A PRODUCTIVITY OR COST VIEWPOINT. SECONDLY, THE WORK STATION LOCATION FOR MANUAL OPERATIONS CAN BE INCORPORATED INTO THE LINE WITHOUT ADVERSE EFFECT ON FLOW. SOME DEGREE OF SEMI-AUTOMATION IS POSSIBLE TO LESSEN THE LABOR INTENSITY OF THIS AREA.

FEASIBILITY: THIS ELEMENT OF THE SYSTEM IS FEASIBLE AND EQUIPMENT IS READILY AVAILABLE.

1.5.7 TRANSPORTATION AND HANDLING FEASIBILITY

CRITERIA: THE DEVELOPMENT OF COST-EFFECTIVE TRANSPORTATION AND HANDLING EQUIPMENT FOR TRANSPORTING RAW MATERIAL AND FINISHED WEBS IS NECESSARY.

RESEARCH CONCLUSIONS: EQUIPMENT REQUIRED FOR THESE PROCEDURES WAS PREVIOUSLY DESIGNED, AND TESTED, AND HAS BEEN IN USE AT ASI FOR SOME TIME.

FEASIBILITY: OUR PREVIOUS RESEARCH HAS DETERMINED THE FEASIBILITY OF THIS ITEM.

1.5.8 COMPUTER SOFTWARE FEASIBILITY

CRITERIA: DEVELOPMENT OF SUPPORT SOFTWARE-FOR VARIOUS PHASES OF SAWL. THE RIGHT PACKAGE WOULD HAVE DETAILED DRAWING CAPABILITIES; CONCURRENT SELECTION BILLS OF MATERIAL; SHOP PRODUCTION SCHEDULES; MATERIALS-FLOW ROUTING; CUTTING LIST; ASSEMBLY MARKING; LOADING, DISPOSITION, DELIVERY SCHEDULES. THE INTERFACE

SPECIAL REQUIREMENTS TO BE MET.

FEASIBILITY: SOFTWARE SYSTEMS MEETING CRITERIA ARE
FEASIBLE; DEVELOPMENT AND TESTING ARE NECESSARY,
HOWEVER!

1.6 ANTICIPATED BENEFITS

THE MAJOR BENEFITS OF THIS PROJECT ARE AS FOLLOWS:

- HANDLING AND SET-UP TIME
- BURNING
- BEAM POSITIONING
- BEAM PREPARATION
- WELDING
- FACE PLATE INSTALLATION
- ACCURACY OF FABRICATION

USING AVONDALE SHIPYARD'S PRODUCTION REQUIREMENTS, IT IS
ANTICIPATED THAT MANPOWER SAVINGS IN THE RANGE OF 73.4
PERCENT COULD BE REALIZED,

SECTION TWO

SEMI-AUTOMATIC WEB LINE: A FUNCTIONAL DESCRIPTION

2.1 INTRODUCTORY NOTE

THIS SECTION COVERS THE CONCEPTUAL APPROACH. INCLUDED IS A STEP-BY-STEP CONCEPTION OF THE SYSTEM, THE CONCEPT DRAWINGS OF THE LINE LAYOUT, MACHINE DRAWINGS AND SPECIFICATIONS, AND OTHER APPROPRIATE DRAWINGS. AVONDALE SHIPYARD'S EXISTING METHODS AND SYSTEMS WERE USED AS A BASE FROM WHICH TO PLAN AND COMPARE THE REQUIRED FACILITIES, PRODUCTION SEQUENCE, WORK FLOW, AND PRODUCTION RATES. REALIZING PERMANENT INCREASING COSTS IN THE SHIPBUILDING INDUSTRY AND PERMANENT GROWING COMPETITION BY LOW COST COUNTRIES, ASI HAS IMPROVED CONTINUOUSLY THE MOST IMPORTANT AREAS OF THE YARD: PANEL WELDING, PIPE PROCESSING, LIGHT METAL PRODUCTION ETC. AS AN ESSENTIAL ELEMENT FOR MODERNIZATION OF HULL FABRICATION, NEW SEMI-AUTOMATIC BEAM PROCESSING LINES AND SEMI-AUTOMATIC WEB PROCESSING LINES MUST BE CONSIDERED. WEBS ARE TO BE PRODUCED HAVING A LENGTH OF UP TO 54 FT. AND A WIDTH OF UP TO 13 FT.

* CUT PLATE THICKNESS	5 1/6TH IN. TO 1 IN.
. BEAM LENGTH	1 FT. TO 13 FT.
. BEAM WIDTH	4 IN. TO 18 IN,
. BEAM THICKNESS	1/4 IN. TO 1 IN.

THE FOLLOWING BEAMS MAY BE USED, PROVIDING THEIR CROSS SECTIONS LIE WITHIN THE BEAM SILHOUETTE SHOWN IN FIGURE 1: FLAT BEAMS, T-BEAMS, L-BEAMS, BULB-BEAMS, BUILT-UP-BEAMS. AUTOMATED POSITIONING AND WELDING IS ONLY POSSIBLE FOR STRAIGHT AND PARALLEL BEAMS, VERTICALLY POSITIONED. MOREOVER, THE DISTANCE BETWEEN TWO BEAMS MUST BE GREATER THAN THE MINIMUM DISTANCE SHOWN IN FIGURE 2. THESE LIMITATIONS ARE DETERMINED BY THE TECHNICAL LIMITS OF THE AUTOMATIC BEAM POSITIONING DEVICE. IN ACCORDANCE WITH U. S. STANDARDS, STRAIGHTNESS OF THE PROFILE HAS TO BE $0.002x$ LENGTH. BRACKETS OR SPECIAL TYPES OF BUILT-UP BEAMS MUST BE POSITIONED BY CRANE OR OTHER MEANS.

2.2 CORE CONCEPT

THE PROPOSED SYSTEM IS APPROACHED SO AS TO BE AN INTEGRATED AND AUTOMATED PRODUCTION LINE. AUTOMATION OF THE MOST CRITICAL AND MOST INTENSIVE PROCESSES WAS GIVEN PRIMARY EMPHASIS. THE MOST CRITICAL PROCESSES CONSIDERED FOR MAXIMUM AUTOMATION WERE MARKING, CUTTING, BEAM AND OTHER STIFFENER PLACEMENT AND WELDING, HANDLING AND TRANSPORTATION. AMONG THE BENEFITS OBSERVED WHICH THIS AUTOMATION AFFECTS ARE: MAN-HOUR SAVINGS, STANDARDIZATION OF METHODS; IMPROVED FABRICATION PRECISION, CENTRALIZED CONTROL OF SCHEDULING, MATERIAL HANDLING, AND OTHERS .

2.3 PRINCIPAL FEATURES

THE PRINCIPAL FEATURES OF THIS SAWL ARE AS FOLLOWS:

- MATERIAL HANDLING
- REDUCED SET-UP TIME
- REDUCED MANUAL FITTING AND TACKING
- ACCURATE AND EFFICIENT MARKING
- CONTROLLED AND EFFICIENT WORK FLOW
- ACCURACY OF FABRICATION
- CONTROLLED WELDING QUALITY AND SPEED
- FLEXIBILITY
- MANUAL AND AUTOMATIC CONTROL
- LARGE WEB FABRICATION ALONG WITH SMALLER ITEMS PERMITTING INTERCHANGEABLE PRODUCTION AT THE SAME WORK STATIONS
- INTEGRATION WITH OTHER MANUFACTURING AND ASSEMBLY PROCESSES

2.4 GENERAL CONDITIONS

THIS SEMI-AUTOMATIC WEB LINE IS SUBJECT TO THE CONDITIONS LISTED IN THE FOLLOWING SECTIONS, 2.5 THRU 2.10.

2.5 STRUCTURAL COMPONENTS

WEB PLATE SIZES VARYING IN LENGTH AND WIDTH UP TO 54 FT. LONG By 13 FT. WIDE AND HAVING A PLATE THICKNESS FROM 5/16TH IN. TO 1 IN. BEAMS TO BE WELDED TO THE ABOVE WEB PLATES CAN VARY IN SIZE AS FOLLOWS:

- BEAM LENGTH FROM 1 FT. TO 13 FT.
- BEAM WIDTH FROM 4 IN. TO 18 IN.
- BEAM WEB THICKNESS FROM 1/4 IN. TO 1 IN.

BEAMS THAT CAN BE AUTOMATICALLY POSITIONED AND WELDED ARE:
FLATS, T-BEAMS, L-BEAMS, BULB-BEAMS, OR WILT-UP BEAMS,
PROVIDING THEIR CROSS SECTIONS LIE WITHIN THE BEAM SILHOUETTE
SHOWN IN FIGURE 1. ADDITIONALLY, SUCH BEAMS MUST BE STRAIGHT,
PARALLEL AND VERTICALLY POSITIONED. THE DISTANCE BETWEEN BEAMS
MUST BE GREATER THAN THE MINIMUM SHOWN IN FIGURE 2. STRAIGHT-
NESS OF THE BEAMS MUST BE $0.002 \times \text{LENGTH}$. ALL OTHER SIZES
AND SHAPES MUST BE INSTALLED BY CONVENTIONAL MEANS. STANDARD
PLATE UTILIZED BY THIS SYSTEM WILL BE 41 FT. BY 13 FT.

2.6 MARKING REQUIREMENTS

LOCATION AND MARKING OF ALL BEAM LOCATIONS ALONG WITH NUMERICAL
IDENTIFICATION. MARKINGS OF EACH SEPARATE WEB SECTION THAT IS TO
BE CUT FROM A GIVEN PLATE.

2.7 CUTTING REQUIREMENTS

ALL PLATES TO BE AUTOMATICALLY PROFILE CUT WITH TWO-TORCH
PRODUCTION OF MIRROR-SYMMETRIC WORK PIECES, REMAINING CONNECTED
BY TABS SO AS TO RETAIN-POSITIONS RELATIVE TO REFERENCE MARKS.

2.8 BUTT WELDING REQUIREMENTS

AUTOMATIC WELDING OF TOP SEAMS IS REQUIRED FOR OVERSIZED WEB
PLATES .

2.9 BEAM POSITIONING AND WELDING REQUIREMENTS

ACCURATE, AUTOMATIC POSITIONING AND WELDING OF ALL BEAMS
DESCRIBED-IN THE PREVIOUS SECTION.

2.10 BEAM PREPARATION REQUIREMENTS

SURFACE TO BE WELDED IS SHOT-BLASTED, BEAM ARE PALLETIZED AND SEQUENCE POSITIONED FOR AUTOMATIC FEED TO THE BEAM POSITIONING AND WELDING MACHINE.

2.11 SYSTEM CAPACITY

5 TONS PER HOUR, OR 16,000 TONS PER YEAR (BASED ON 3,300 WORKING HOURS ON TWO SHIFTS) EQUIVALENT APPROXIMATE SYSTEMS CAPACITY; ALL WEB REQUIREMENTS FOR FIVE 40,000 TON BULK CARRIES PER YEAR.

2.12 MANPOWER REQUIREMENTS

REFERENCE WEBS:	1.45 MAN-HOURS
LARGE WEBS:	45 MAN-HOURS

MANNING REQUIREMENTS OF THE PRODUCTION LINE VARY FROM APPROXIMATELY 7 MEN WHILE PRODUCING SMALL WEBS, TO 16 MEN FOR PRODUCTION OF LARGE WEBS. CYCLE TIMES ARE 310 MIN. FOR 24 REFERENCE WEBS, AND 165 MIN. FOR EACH LARGE WEB.

2.13 DAILY PRODUCTION RATES

REFERENCE WEBS:	74.32 PIECES PER DAY
LARGE WEBS:	5.81 PIECES PER DAY
WORKING HOURS PER SHIFT:	8
SHIFTS PER DAY:	2

2.14 TIME COMPARISON

(BASED ON AVONDALE SHIPYARDS REQUIRED TONNAGE)

CURRENT SYSTEM	93,818 MAN-HOURS
NEW SAWL SYSTEM	24,954 MAN-HOURS
SAVINGS	68,864 MAN-HOURS

2.15 NEW SAWL SYSTEMS SUMMARY

SUMMARIZED BELOW IS THE STEP-BY-STEP WORK STATION METHODOLOGY FOR PROCESSING AND HANDLING WEBS AND LARGE WEB FRAMES ON THE NEW SEMI-AUTOMATIC WEB LINE. THIS SYSTEM IS PLAN A AND IS SHOWN ON THE DRAWING LABELED LAYOUT PLAN A. THE NUMERICAL REFERENCES THROUGHOUT THIS SUMMARY REFER TO THE ABOVE MENTIONED DRAWING WHICH CAN BE FOUND IN THE NEXT FOLLOWING SECTION.

SAWL PLAN A

PLAN A IS A TWO-LANE WEB FABRICATION-LINE INCLUDING THE CUTTING, MARKING AND LABELING FOR THE FLOW FABRICATION OF WEBS UP TO MEDIUM SIZES, COMBINED FLOW FABRICATION FOR LARGE WEBS WITH THE SUBSEQUENT APPLICATION OF FACE PLATES ON STATIONARY INDIVIDUAL STATIONS, TURNING OF WEBS, THERMAL STRAIGHTENING, AND PROVISION FOR BEAMS AND STIFFENERS ON THE BACK SIDE. THE BASIC PLATES OF LARGE WEBS ARE MADE FROM SEVERAL CUT PARTS USING CONVENTIONAL SUBMERGED-ARC WELDING AND WELDING TRACTORS. THE WEB FABRICATION LINE SHOWN ON THE DRAWING FOR PLAN A IS A TWO-LANE LINE ON WHICH THE FOLLOWING TYPES OF FABRICATION CAN BE CARRIED OUT AS REQUIRED:

- PARALLEL OPERATION OF STATION I THRU VII FOR THE SERIES PRODUCTION OF SMALL AND MEDIUM WEBS.
- FABRICATION OF LARGE WEBS, STATIONS I THRU IX
- MIXED FABRICATION

THE THROUGHPUT AND PERSONNEL REQUIREMENTS VARY WITH THE TYPE OF FABRICATION SELECTED. ALL PRIMED SECTIONS PASS THROUGH THE AUTOMATIC BEAM EDGE CLEANING UNIT, STATION X, TO REMOVE THE PRIMER FROM THE EDGES OF THE BEAMS TO BE WELDED.

ON BOTH LINES THE WEBS ARE TRANSPORTED ON TRANSPORT TABLES, TWO COUPLED TO ONE UNIT IN EACH CASE.

ALL TRANSPORT TABLES ARE EQUIPPED WITH CORRUGATED CUTTING SURFACES ON WHICH THE SECTIONS ARE POSITIONED AND WELDED. THE EMPTY TRANSPORT TABLES ARE RETURNED WITHOUT CRANE USE, USING TWO CROSS TRAVEL UNITS AT THE TOP END OF THE DRAWING AND A THIRD PAIR OF RAILS. (RETURN OF TRANSPORT TABLES VIA CRANE IS POSSIBLE IF DESIRED.)

THE LENGTH OF THIS TWO-LANE LINE WITH RETURN TABLE AND NINE PARALLEL STATIONS IS ABOUT 561 FT. WITH A WIDTH, INCLUDING THE OPERATING WALK WAY AND TRACKS FOR THE RETURN OF TABLES, OF 90 FT. THE SHOP CRANE MUST HAVE A LIFTING CAPACITY OF 20 TONS.

FABRICATION OF LARGE WEBS (STATIONS I - IX)

AND FABRICATION OF SMALL AND MEDIUM WEBS (STATION I - VII)

2.15.1 STATION I

AT STATION 1 THE TRANSPORT TABLES ARE PARKED ON THE RETURN TRACK AND CROSS CONVEYED TO LANE ONE AND TWO AND COUPLED TO TWO DOUBLE TRANSPORT TABLES.

2.15.2 STATION II

AT STATION II PLATES UP TO A WIDTH UP-TO 13 FT. AND A LENGTH OF 41 FT. ARE PLACED ON THE TRANSPORT TABLES BY THE SHOP CRANE, EQUIPPED WITH MAGNET TRAVERSE, AND AGAINST A LONGITUDINAL AND TRAVERSE REFERENCE EDGE. THEREAFTER, ALL BEAM POSITIONS (LINES, AUXILIARY LINES FOR CUTTING AND REFERENCE MARKS) ARE POWDER MARKED UNDER THE PROGRAM CONTROL FOR SUBSEQUENT AUTOMATIC POSITIONING AT STATION V.

THE SECOND OPERATION IS THEN TO APPLY LABELING TO THE BASIC WEB PLATE APPLYING SERIES, TYPE AND/OR ITEM NUMBER USING A SPECIAL INK SPRAY HEAD ON A PORTAL TROLLEY.

FOR INDIVIDUALLY FABRICATED LARGE WEBS THE TROLLEY FOR THIS PORTAL IS EQUIPPED WITH-A THREE-TORCH CUTTER UNIT, FOR TORCH CUTTING WITH WELD PREPARATION. IF ONE ASSUMES THAT THE BASIC PLATE FOR A LARGE WEB IS COMPRISED OF FOUR INDIVIDUAL SECTIONS (OF WHICH TWO EACH ARE CUT FROM ONE PLATE), A TOTAL OF SIX BUTT WELD JOINTS MUST BE MADE ON THE PLATES IN BOTH LANES WITH A MEAN LENGTH OF 45 FT. AT THIS STATION.

AT WELDING SPEED $V = (0.8 \text{ FT. PER MIN.})$, 80 MIN. INCLUDING WAITING TIME IS REQUIRED FOR THIS PURPOSE. ESTIMATED MARKING TIME IS 30 MIN., LABELING TIME 20 MIN., AND CHARGING TIME 20 MIN. THE TIME THAT THIS DOUBLE STATION IS OCCUPIED IS ABOUT 150 MIN. OR 2.5 HOURS.

2.15.3 STATION III

CONTOUR TORCH CUTTING OF THE FOUR BASIC PLATE PARTS TAKES PLACE ON BOTH LINES OF STATION III. A LARGE WEB HAS AN ESTIMATED CONTOUR CUT LENGTH OF ABOUT 182 FT. RESULTING IN A FLOOR-TO-FLOOR TIME OF 155 MIN. OR 2.58 HOURS. THIS INCLUDES ABOUT 120 MIN. OPERATING TIME AND ABOUT 35 MIN. WAITING TIME. ON STATION 111 WHEN PRODUCING SMALL WEBS THE BASIC PLATE IS CUT WITH A TWO TORCH PORTAL AND THE TORCH BUGGY MOVES MIRROR-SYMMETRIC IN THE TRANSVERSE AXIS SO THAT TWO MIRROR-SYMMETRIC PARTS (BASIC PLATES) ARE CUT ON LANES ONE AND TWO, THE INDIVIDUAL PART REMAINING CONNECTED BY TABS, THEREBY PERMITTING THEM TO RETAIN THEIR POSITION RELATIVE TO THE TWO REFERENCE MARKS.

2.15.4 STATION IV

ON STATION IV WHEN PRODUCING LARGE WEBS THE SHOP CRANE PLACES THE FOUR BASIC PLATE PARTS, CUT AND WITH PREPARED BUTT WELD JOINTS; INTO A SPECIFIC POSITION ON THE TRANSPORT TABLES OF LANE TWO. THEY ARE THEN SUBMERGED-ARC WELDED WITH TRACTORS ON ONE SIDE ONLY. HERE-THE PARTS OF THE BASIC PLATE THAT OVERHANG THE TRANSPORT TABLE ARE SUPPORTED WITH EXTRA TABLES.

EMPIRICAL VALUES FOR CONVENTIONAL SUBMERGED-ARC THREE-PASS BUTT WELDING OF THREE SEAMS WITH A MEAN LENGTH OF 8 FT. AND A PLATE -THICKNESS OF Approximately 7/8TH IN. IS APPROXIMATELY. 240 MIN. OR 4 HOURS INCLUDING ALL WAITING TIME. THEREFORE AT LEAST TWO SUBMERGED-ARC WELDING TRACTORS, OPERATING IN PARALLEL, ARE REQUIRED TO PRODUCE A FLOOR-TO-FLOOR TIME OF APPROXIMATELY 2 HOURS. STATION IV IS EMPTY DURING PRODUCTION OF SMALL AND MEDIUM SIZE WEBS.

2. 15. 5 STATION V

THE AUTOMATIC POSITIONING AND WELDING MACHINE BRIDGING BOTH LANES IS LOCATED AT STATION V. DURING THE FIRST OPERATION PER PLATE, THE MACHINE, PHOTO-ELECTRICALLY CONTROLLED, SCANS THE TWO REFERENCE MARKS AND HAVING DETERMINED THEIR POSITION SETS THE POSITIONING PROGRAM GEOMETRICALLY TO "0". THE PORTAL CARRIES THE BEAM PALLET TRANSPORTER FROM WHICH THE MACHINE'S BEAM-GRAB-HEAD TAKES THE PRESORTED BEAMS FOR FABRICATION.

APPROPRIATE TO THIS PROGRAM, THE PORTAL AND THE Transverse BUGGY TRAVEL IN THE X AND Y DIRECTION, THE HEAD TURNS TO THE DESIRED POSITIONING LOCATION AND POSITIONS THE BEAMS AUTOMATICALLY ABOUT 1 FT. ABOVE THE BASIC PLATE.

THE AUTOMATIC CONTROL CAN THEN BE OVERRIDDEN BY HAND SHOULD A CORRECTION BE NECESSARY TO THE POSITION TAKEN BY THE BEAM. THE BEAM IS THEN LOWERED, PRESSED DOWN AT THE SAME TIME AND WELDED, USING FOUR FLUX CORED WIRE WELDING MACHINES APPLIED AT THE SAME TIME TO BOTH SIDES FROM THE CENTER OF THE BEAM OUTWARD TOWARDS BOTH ENDS. THEREAFTER THE PRESS-DOWN

PLUNGERS ARE RAISED AND THE WELDING CAR TRAVELS TO THE PARK POSITION. THE MACHINE IS THEN READY TO TAKE A NEW BEAM. THE CYCLE TIME (FLOOR-TO-FLOOR) FOR A BEAM 6 FT. LONG IS APPROXIMATELY 4.5 MIN.

ON A LARGE WEB AN AVERAGE OF 25 BEAMS WITH AN OVERALL LENGTH OF ABOUT 110 FT. CAN BE AUTOMATICALLY POSITIONED AND WELDED; THIS FLOOR-TO-FLOOR TIME CAN BE HANDLED IN ABOUT 80 MIN.

2.15.6 STATION VI

BEAMS SHORTER THAN 3 FT. , BEAMS WITH A CROSS SECTION NOT SUITABLE FOR THE BEAM CARRIER, OR BEAMS WHICH ARE INCLINED CANNOT BE HANDLED BY THE MACHINE AT STATION V. THEY ARE TAKEN FROM THE BEAM PALLETS AT STATION VI WITH A-MANUALLY CONTROLLED MANIPULATOR, MOVED ACROSS THE BASIC PLATE, POSITIONED, HELD VERTICAL, PRESSED DOWN AND TACK WELDED. WELDING AT THIS STATION IS DONE BY ELECTRODES. HERE THE INCIDENTAL WORK SUCH AS WELDING THE FINAL SEAMS ON THE BEAM" ENDS AND THE VERTICAL SEAMS AT THE BEAM JOINTS IS ACCOMPLISHED.

THE TABS ARE REMOVED USING CONVENTIONAL CUTTING TORCHES AND GRINDERS. -

AVERAGELY 14 BEAMS ARE MANUALLY WELDED ON A LARGE WEB - AND REQUIRE APPROXIMATELY TWO MAN-HOURS FOR THIS WORK. AN ADDITIONAL TWO MAN-HOURS ARE REQUIRED FOR FURTHER SUPPLEMENTARY WORK SUCH AS FINAL WELDING, VERTICAL WELDING, DE-SLAGGING, AND ALIGNING.

2.15.7 STATION VII (SMALL AND MEDIUM WEBS)

IN THE CASE OF SERIES FABRICATION OF SMALL AND MEDIUM WEBS, THE WEBS ARE REMOVED AT STATION VII BY THE SHOP CRANE AND PUT INTO THE WEB PALLET. THE DOUBLE TRANSPORT TABLE IS UNCOUPLED AND AS DESCRIBED IN STATION I, TRANSVERSE TRAVELLED TO THE RETURN TRACK. THIS TRACK COULD ALSO BE LOCATED OUTSIDE OF THE SHOP. DURING THE RETURN AND IN THE PARKING AREA FOR TRANSPORT TABLES, ANY SCRAP AND SLAG REMAINING IS REMOVED CONVENTIONALLY.

2.15.8 STATION VII AND VIII (LARGE WEBS)

AT STATION VII TWO SPECIAL FACE PLATE MANIPULATORS RAISE THE LARGE WEB, STILL ON COUPLED TRANSPORTER TABLES, SO THAT TRANSPORT ROLLS CAN BE PUSHED BETWEEN THE BOTTOM OF WEB AND THE CORRUGATED CUTTING SUPPORTS OF THE TRANSPORT TABLE. THEREAFTER, THE SPECIAL FACE PLATE MANIPULATORS REMOVE THE LARGE WEB, AND THE TABLE CAN THEN BE REMOVED. THE OFF-LOADED TRANSPORT TABLE CAN THEN BE POSITIONED ON THE RETURN TRACK USING THE CROSS-TRANSPORT SYSTEM. AFTER THE SUPPORTS ARE POSITIONED, THE HALVES OF THE FACE PLATE ARE PLACED AND PREPOSITIONED. BY THE SHOP CRANE PRIOR TO WELDING. IT IS THEN POSSIBLE, USING THE FACE PLATE MANIPULATOR, TO PRESS THE FACE PLATE INTO THE CONTOUR OF THE BASIC PLATE IN SUCH A WAY THAT THE CORRECT HEIGHT AND VERTICAL POSITION OF THE FACE PLATE CAN BE SELECTED AND INITIALLY TACK WELDED. AFTER TACKING, IT CAN BE COMPLETELY WELDED FROM THE TOP SIDE ONLY. WHEN NECESSARY, THE FACE PLATE RADIUS CAN BE POST-SHAPED UNDER THE

APPLICATION OF HEAT. BY USING SPECIAL FACE PLATE MANIPULATORS THE WORK REQUIRED FOR THE FLANGE WELDING OPERATION IS DRASTICALLY REDUCED COMPARED TO THE CURRENT PRACTICES.

2.15.9 STATION IX

STATION IX COMPRISES A NUMBER OF ADJUSTABLE INDIVIDUAL SUPPORTS TO SUPPORT THE LARGE WEBS WHICH WERE TRANSPORTED BY SHOP CRANE AND TURNED OVER DURING LOWERING. THE FIRST OPERATION AT THIS STATION IS HEAT STRAIGHTENING UNDER CONVENTIONAL METHODS. A MANIPULATOR, AS IN STATION VI HERE, SERVES FOR BEAM POSITIONING AND WELDING.

THE THIRD OPERATION AT STATION IX IS FINISHING THE WELDING OF THE BUTT WELDS WHICH ARE NOW ON TOP SINCE THE WEB HAS BEEN TURNED OVER, AND WELDING THE SECOND FILLET WELD ON THE FACE PLATE, USING THE FACE PLATE WELDING TRACTORS.

2.15.10 MIXED FABRICATION

MIXED FABRICATION IS POSSIBLE APPROPRIATE TO THE REQUIREMENTS AND CAPACITY OF THE PRODUCTION LANES.

2.15.11 STATION X

STATION X IS A STAND-ALONE STATION FOR AUTOMATIC SHOT-BLASTING OF THE LOWER SURFACE OR SIDES (UP TO ONE IN.) OF BEAMS IN PREPARATION FOR WELDING. THIS STATION ALSO PALLETIZES SEAMS ONTO SPECIAL PALLETS FOR PROPER FEEDING SEQUENCE AND POSITION INTO THE AUTOMATIC BEAM POSITIONING AND WELDING MACHINE.

2. 15. 12 TRANSPORTATION

AT STATION IX THE CRANE REMOVES LARGE WEBS AND PLACES THEM VERTICALLY INTO SPECIALLY DESIGNED PALLETS HAVING VERTICAL SPACERS AND CAPABLE OF-TRANSPORTING SEVERAL WEBS. THESE SPECIAL PALLETS ARE TRANSPORTED BY A PREVIOUSLY DESIGNED 50-TON HYDRAULIC LIFT TRANSPORTER IN CONJUNCTION WITH A LARGE FORK LIFT TRUCK.

2.16 EQUIPMENT REQUIREMENTS

(REFER TO DRAWING MARKED LAYOUT PLAN A IN SECTION IMMEDIATELY FOLLOWING)

	<u>MACHINE DESCRIPTION</u>	<u>NUMBER REQUIRED</u>
Pos. 1.1	BEAM POSITIONING AND WELDING MACHINE	1
Pos. 1.2	CORED WIRE WELDING EQUIPMENT	4
Pos. 1.3	DISPLACEMENT DEVICE FOR BEAM. PALLETS	1
Pos. 2.1	SHOT-BLASTER FOR SEAMS	1
Pos. 2.2	BEAM-FEED DEVICE	1
Pos. 2.3	CROSS TRANSFER FOR BEAM PALLETS	2
Pos. 3.1	SEAM MANIPULATOR	2
Pos. 3.2	MANUAL WELDING UNIT	2
Pos. 4.7	TRANSPORT WAGONS	22
Pos. 4.8	RAILS	3,200 FT.
Pos. 4.9	DRIVES	28
Pos. 4.10	CROSS TRANSPORT	4
Pos. 4.11	LEVELING TABLES	4
Pos. 5	FLAME CUTTING MACHINE	1
Pos. 7	SLAG BOXES	6
Pos. 8	SCRAP BOXES	2
Pos. 9	BEAM PALLETS	10
Pos. 10	WEB TRANSPORT PALLETS	3
Pos. 11	CUTTING MACHINE	1
Pos. 12	SUBMERGED-ARC WELDING TRACTORS	3
Pos. 13	BASE PLATE MANIPULATOR	2

2.17 EQUIPMENT DESCRIPTION (THE POSITIONS REFERRED TO IN THIS SECTION ARE FOUND ON LAYOUT PLAN A IN THE FOLLOWING SECTION.)

PoS. 1.1 POSITIONING MACHINE (SEE DRAWING # 763.06351B)

TECHNICAL DESCRIPTION

THIS MACHINE IS A PORTAL TYPE WITH A GRIPPING BAR. THE BAR SERVES FOR PICKING UP, TRANSPORTING, POSITIONING, CLAMPING AND WELDING. IT IS EQUIPPED WITH A ROW OF MAGNETS AND CYLINDERS AND WELDING UNITS. THE GRIPPING BAR CAN BE ROTATED AND DRIVEN. THERE ARE TWO DOUBLE WELDING UNITS ON THE BAR WHICH START WELDING AT THE MIDDLE OF THE BEAM AND WORK OUTWARD INDEPENDENTLY. THE MACHINE CAN BE PRECISELY CONTROLLED IN EVERY POSITION. ALL MOVEMENTS ARE CONTROLLED WITH SPECIAL BRAKES TO INSURE PRECISE POSITIONING. THE CLAMPING PRESSURE CAN BE PRESELECTED STEPLESSLY. THIS MACHINE HAS BEEN SO DESIGNED THAT BEAMS CAN BE COLLECTED FROM THE MAGAZINE, FED IN SEQUENCE, AND WELDED. THE ELECTRICAL SUPPLY IS PROVIDED VIA A TRAILING CABLE. AS IS THE POWER FOR WELDING AND TRAVEL.

PoS. " 1.3 'DISPLACEMENT DEVICE FOR BEAM PALLETS .

TECHNICAL DESCRIPTION

THE EQUIPMENT DISPLACEMENT-DEVICE FOR BEAM PALLETS IS ATTACHED TO ONE SIDE OF THE PORTAL OF THE BEAM POSITIONING AND WELDING MACHINE, POSITION 1.1.

THE HANGING PLATFORM PICKS UP A FLAT CARRIAGE WHICH IS POWERED ELECTRICALLY AND CAN BE MOVED IN 12 STEPS OF 8 IN. EACH.

THE BEAM PALLETS IN POSITION 9, ARE PLACED ON THE CARRIAGE, AND POSITIONED AND FIXED SO THAT THE EXACT BEAM NEEDED AT ANY GIVEN TIME 1: SENT TO A POSITION UNDERNEATH THE MIDDLE AXIS OF THE PORTAL. AT THIS POINT IT IS TAKEN UP BY THE MACHINE HEAD VIA MAGNETS.

Pos. 1.4 CONTROL, ELECTRONICS AND ENERGY SUPPLY TECHNICAL DESCRIPTION

CONTROL OF THE BEAM POSITIONING AND WELDING MACHINE IS DESIGNED ON A MODULE BASIS. THE SYSTEM CAN BE EXPANDED IN STEPS FROM SIMPLE MANUALLY OPERATED PUSH-BUTTON CONTROL-TO NC AUTOMATIC CONTROL. IT IS OPERATED AND CONTROLLED BY AN OPERATING PANEL WHICH TRAVELS WITH THE MACHINE. THIS PANEL ALSO CONTAINS THE CONTROL ELEMENTS FOR THE FOUR WELDING UNITS AND A FIXED CONTROL UNIT TO WHICH CAN BE ADDED A THERMAL (ALPHA-NUMERIC) OR A GRAPHIC V. D. U. IF DESIRED.

Pos. 2.1 SHOT BLASTER FOR BEAMS (SEE DRAWING # 763.06359B) TECHNICAL DESCRIPTION

THE BEAM CLEANING MACHINE CLEANS BEAMS CARRIED IN AN UPRIGHT POSITION ON THE LOWER SURFACE OR ON BOTH SIDES UP TO A HEIGHT OF 1 IN. ALL THE CONTACT ROLLERS ARE DRIVEN TO INSURE THAT THE BEAM'S PASSAGE IS PERFECT. THE PROPULSION MECHANISM CAN BE ALTERED TO ANY SETTING. THE ENTIRE PLANT IS SEALED SO THAT THE RISK OF BLASTING MATERIAL ESCAPING IS REDUCED TO AN ABSOLUTE MINIMUM. THE UNIT IS SELF-LOADING AND SELF-CLEANING. IT IS FITTED WITH A FILTER WHICH IS ALSO SELF-CLEANING. GRIT IS USED FOR BLASTING. PROVISION IS MADE

BOTH IN FRONT OF AND BEHIND THE MACHINE FOR A CONVEYING SYSTEM. THE EQUIPMENT DOES NOT NEED AN EXHAUST TO THE OUTSIDE. IT CAN BE OPERATED FROM A CONSOLE EITHER MANUALLY OR AUTOMATICALLY .

POS. 2.2 BEAM FEEDING DEVICE

TECHNICAL DESCRIPTION

LOADING AND UNLOADING OF BEAM PALLETS IS PERFORMED BY GRIPPERS ON THE ENTRANCE AND EXIT SIDES OF THE BLASTING MACHINE, WORKING IN CONJUNCTION WITH CONVEYERS AND A DEVICE TO KEEP THE BEAMS IN AN UPRIGHT POSITION.

Pos. 2.3 CROSS TRANSFER FOR BEAM PALLETS

TECHNICAL DESCRIPTION

BEAM PALLETS ARE DISPLACED WITH THE AID OF THE CROSS TRANSFER MACHINE. THIS MACHINE CONSISTS OF A PAIR OF RIGID TRANSPORT CHAINS, GUIDED BY RAILS. THEY HAVE A POSITIONING DEVICE FOR THE BEAM PALLETS, AND ARE POWERED BY AN ELECTRIC MOTOR. THERE IS ALSO A POSITION INDICATOR.

Pos. 2.4 CONTROL SYSTEM IN ELECTRONICS

TECHNICAL DESCRIPTION

THE CROSS TRANSFER FOR BEAM PALLETS, POSITION 2.3, THE BEAM FEED DEVICE, POSITION 2.2, AND THE SHOT BLASTER FOR BEAMS, POSITION 2.1 ARE OPERATED VIA A CONTROL SYSTEM AT EACH STATION. THIS SYSTEM IS SITUATED AT THE STATION'S OPERATING DESK, PROVIDES ELECTRIC CURRENT AND CONTAINS THE MONITORING, AND OPERATING CONTROLS AND INSTRUMENTS.

Pos. 3.1 BEAM MANIPULATOR (SEE DRAWING # 763;06363-8)

TECHNICAL DESCRIPTION

THE BEAM MANIPULATOR CONSISTS OF A STRONG SINGLE-GIRDER-PORTAL RUNNING ON FLOOR RAILS, PLUS A CROSS TRANSFER CARRIAGE WHICH TRAVELS LATERAL TO THE PORTAL GIRDER. ON THE CARRIAGE IS A FIXED VERTICAL GUIDING DEVICE FOR THE GRIPPING COLUMN, WITH A COMBINED SEAM-GRIPPER AND CLAMPING HAND. THIS DEVICE CAN GRIP AND POSITION BOTH PARALLEL BEAMS, AND BEAMS WITH THE UPPER SURFACE HAVING AN ANGLE OF UP-TO 45 DEGREES, PROVIDED THAT THE BEAM CROSS SECTION LIES WITHIN THE BEAM'S SILHOUETTE SHOWN IN FIGURE 1. ALL WHEEL SHAFTS ARE ELECTRIC DRIVEN WITH A PRECISE PROPULSION MECHANISM THAT IS CONTROLLED VIA THE SENSORS IN BOTH GRIPPER ARMS AND ON THE GRIPPER COLUMN. THE SENSOR GRIPPER ARMS REACT TO TENSION, PRESSURE, BENDING AND ROTATION SO THAT NO PHYSICAL STRENGTH IS REQUIRED OF THE OPERATOR. ALL CONTROL COMMANDS FOR TRAVEL IN THE X, Y, & Z DIRECTION, ROTATION AROUND THE ALPHA AXIS, AND OPENING OR CLOSING OF THE GRIPPER HAND, ARE CARRIED OUT BY SIMPLE "GUIDING" OF THE MANIPULATOR BY THE GRIPPER HANDS.

POS. 3.2 ELECTRODE WELDING EQUIPMENT

TECHNICAL DESCRIPTION

THE ELECTRODE WELDING EQUIPMENT-REQUIRED FOR MANUAL WELDING OF BEAMS POSITIONED BY THE MANIPULATOR (SHORTER THAN 3 FT. OR SPECIAL BEAMS) AND ANY NECESSARY FINISHING IS DONE WITH CONVENTIONAL-EQUIPMENT OF PROVEN QUALITY. DEPENDING ON LOAD THROUGHPUT, TWO OR FOUR UNITS WILL BE NEEDED.

Pos. 3.3 CONTROL AND ENERGY SUPPLY

TECHNICAL DESCRIPTION

POWER FOR THE BEAM MANIPULATOR, POSITION 3, IS SUPPLIED TO A SWITCH AND CONTROL BOX WHICH ALSO MONITORS LOAD AND CONTROLS TRAVEL ROUTE, LENGTH AND SPEED. POWER IS SUPPLIED VIA A TRAILING CABLE, BY MEANS OF A CABLE SUSPENDER. THE ELECTRODE WELDING EQUIPMENT IS PROVIDED WITH ENERGY INDEPENDENT OF THE MANIPULATOR.

Pos. 4.0 TRANSPORT SYSTEM

IN GENERAL THE SYSTEM CONSISTS OF:

- . THE TRANSPORT TABLES THEMSELVES
- . THE CUTTING GRATES ON THE TABLES
- . LINE TRACKS AND RETURN TRACKS
- . CROSS-OVER TRACKS
- DRIVING AND BREAKING SYSTEM
- . CONTROL AND ENERGY SUPPLY

Pos. 4.1 TRANSPORT WAGON

STEEL BED TRANSPORT WAGONS HAVING A REPLACEABLE CORRUGATED DECK SUITABLE FOR BURNING AND WELDING, AND A MEANS OF BEING MOVED INTO POSITION ARE DESIGNED FOR THIS SYSTEM.

POS. 4.8 CONTROL AND ENERGY SUPPLY

TECHNICAL DESCRIPTION

SINCE AN AVERAGE OF 12 REFERENCE-WEBS ARE PRODUCED ON A TRANSPORT WAGON WITH A CYCLE TIME OF 12.5 MIN. THE WAGONS HAVE TO BE MOVED SIMULTANEOUSLY EVERY 150 MIN. TO MAKE THIS

POSSIBLE THEY HAVE TO BE CONTROLLED IN REGARD TO SPEED AND BREAKING. AT THE SAME TIME, THE BEAM POSITIONING AND WELDING MACHINE, POSITION 1.1, AND THE BEAM MANIPULATOR, POSITION 3.1, MUST BE HALTED IN THEIR MOVEMENTS AND THE OPTICAL AND ACOUSTICAL WARNING SYSTEM STARTED. THERE IS-A CONTROL AND POWER CABINET TO SUPPLY AND CONTROL THE DRIVING DEVICES FOR THIS SYSTEM.

Pos. 5 FLAME CUTTING MACHINE

TECHNICAL DESCRIPTION

ON PLAN A, A FOUR-BURNER PORTAL CUTTING UNIT IS INCORPORATED WHICH BRIDGES BOTH LANES. DEPENDING ON THROUGHPUT, EITHER A FLAME OR A PLASMA CUTTING SYSTEM IS USED.

Pos. 9 BEAM PALLET

TECHNICAL DESCRIPTION

BEAM PALLETS ARE NEEDED FOR THE TRANSPORT OF PRE-SORTED BEAMS BETWEEN 4 IN. AND 18 IN. IN HEIGHT AND UP TO 13 FT. LONG.

. THE PALLETS MAY BE USED ON THE TRANSFER SYSTEM OF THE SHOT-BLASTER FOR BEAMS, POSITION 2.3, FOR THE PALLET DISPLACEMENT DEVICE, POSITION 2.1, AS WELL AS FOR THE PREPARATION OF BEAMS SHORTER THAN 3 FT. TO BE-POSITIONED BY THE BEAM MANIPULATOR. THE PALLETS HAVE SLOTS FOR HOLDING BEAMS IN A VERTICAL POSITION.

Pos. 10 WEB PALLET

TECHNICAL DESCRIPTION

A PALLET FOR TRANSPORTING WEBS AND STEEL PLATES WAS PREVIOUSLY DESIGNED AND CONSISTS OF THREE ELEMENTS:

1. A LARGE STEEL PALLET (SKID) WITH VERTICAL POSTS
2. A 50-TON HYDRAULIC LIFT TRANSPORTER
3. A LARGE FORK LIFT FOR PROVIDING HYDRAULIC POWER AND TRACTIVE EFFORT

Pos. 13 FACE PLATE MANIPULATOR

TECHNICAL DESCRIPTION

A MOBILE FACE PLATE MANIPULATOR MUST BE DESIGNED TO GRIP, TRANSPORT, AND POSITION FACE PLATES. THESE MANIPULATORS MUST BE MANUALLY CONTROLLED AND BE CAPABLE OF HOLDING THE FACE PLATE FIRMLY IN POSITION DURING THE INITIAL TACKING OPERATION.

2.18 EXISTING EQUIPMENT UTILIZATION LISTING

THE FOLLOWING EQUIPMENT IS ALREADY USED BY ASI AND MAY BE USED IN CONJUNCTION WITH THIS WEB LINE:

- PALLET TRANSPORT SYSTEM FOR THE TRANSPORTATION OF PLATES OR COMPLETE WEBS WHICH HAVE A TOTAL WEIGHT GREATER THAN 1 TON
- A CRANE WITH A LOADING CAPACITY OF APPROXIMATELY 10 TONS WHICH BRIDGES THE ENTIRE LINE. THE CRANE SHOULD BE OPERABLE FROM THE SHOP FLOOR AND-FITTED WITH POWER AND CREEP SPEED
- FORK TRUCKS TO CARRY BEAM PALLETS
- ELECTRODE WELDING UNITS FOR MANUAL TACKING AND WELDING OF BEAMS SHORTER THAN 3. FT. AND FOR FINISHING THE LONGER BEAMS

2.19

SAWL: SYSTEM SKETCHES

THE FOLLOWING SKETCHES PROVIDE GRAPHIC PERSPECTIVE OF THE SEMI-AUTOMATIC WEB LINE AS ENVISIONED-AND DESCRIBED-IN THE PREVIOUS SECTION.

- LAYOUT OF PLAN A ILLUSTRATES WORK STATIONS AND PRODUCTION FLOW AND PLAN AND ELEVATION VIEWS.
- MACHINE DRAWINGS SHOWING MORE DETAIL OF THE MAJOR MACHINE COMPONENTS.
- FLOW CHARTS SHOWING PRODUCTION RATES AND WORK FLOW BY STATIONS. PHOTOGRAPHS SHOWING A PERSPECTIVE OF THE SCALE MODEL.

BEAM SILHOUETTE

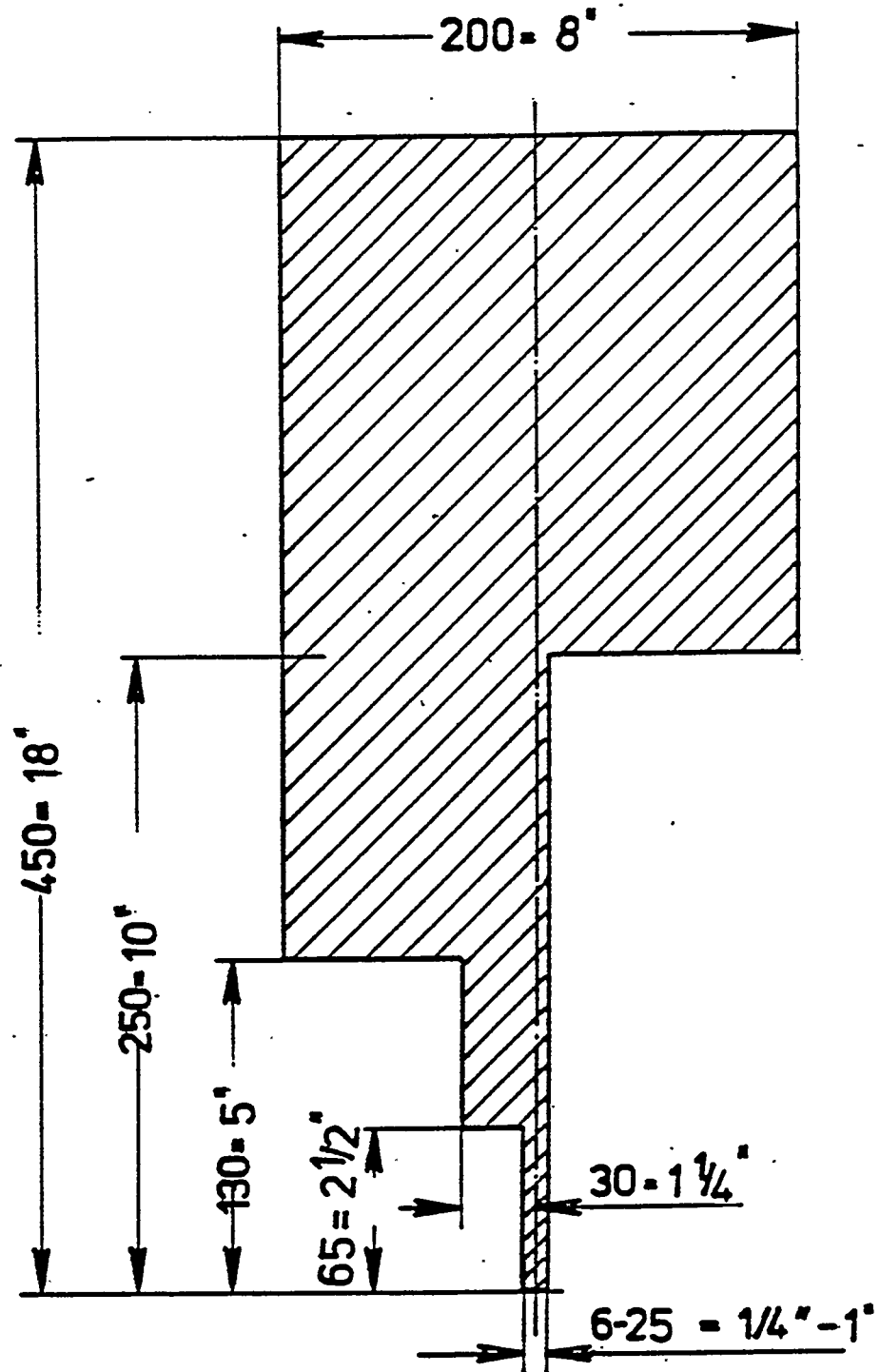


FIGURE 1



FIGURE 2

PRODUCT-FLOW-RATE Reference Web Proposal: A

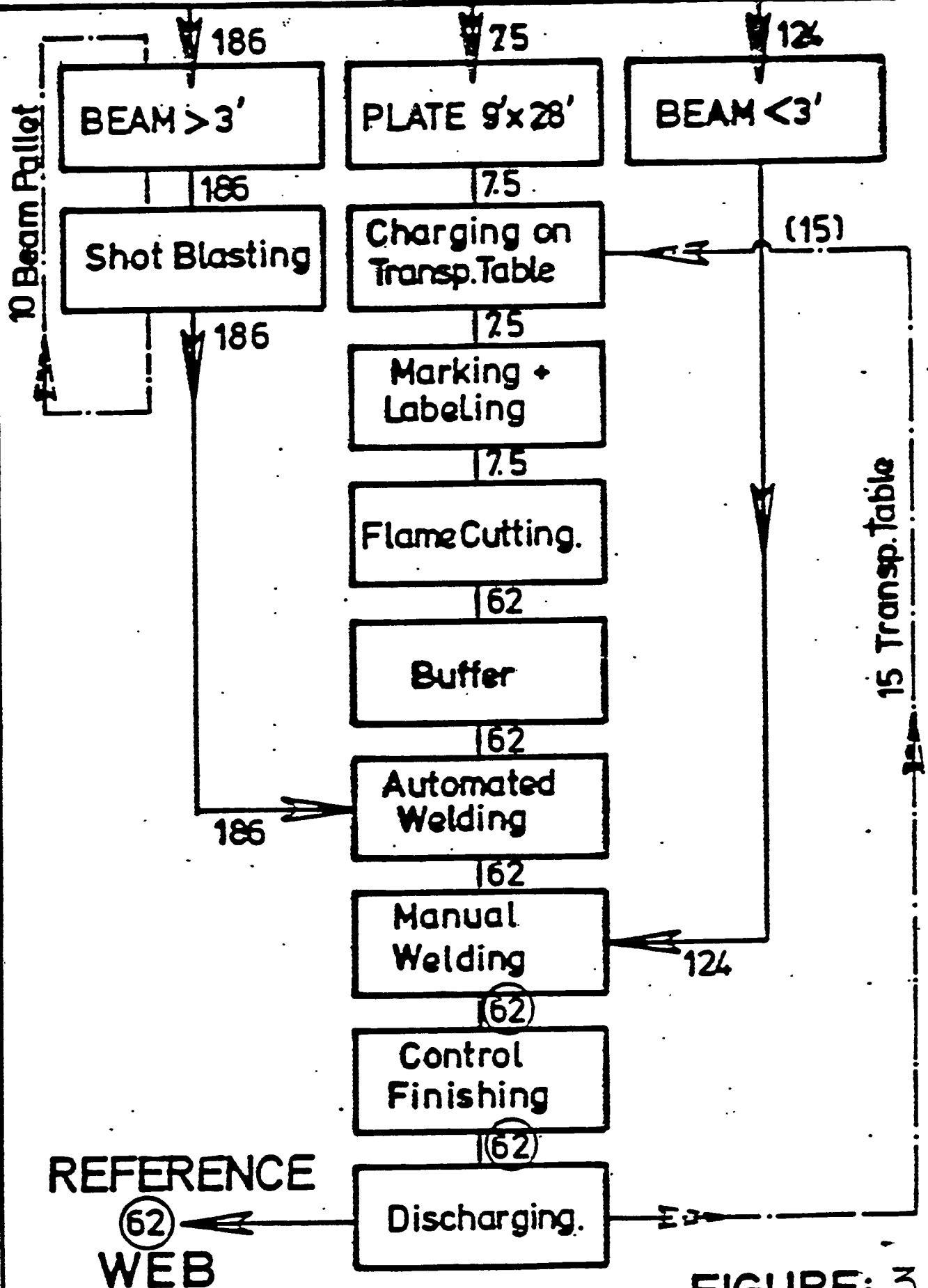
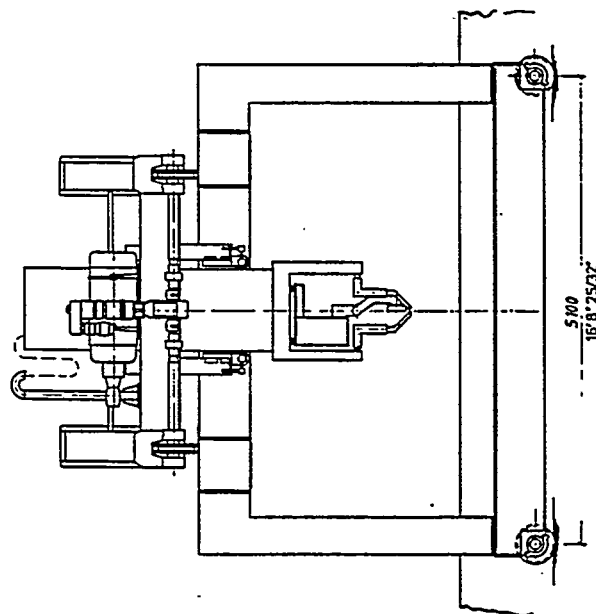
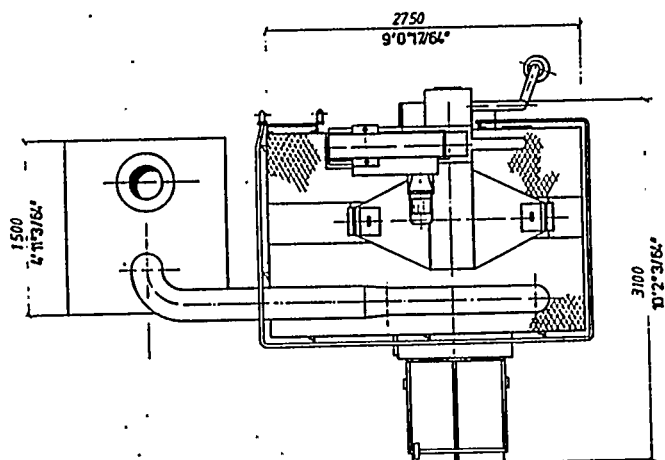
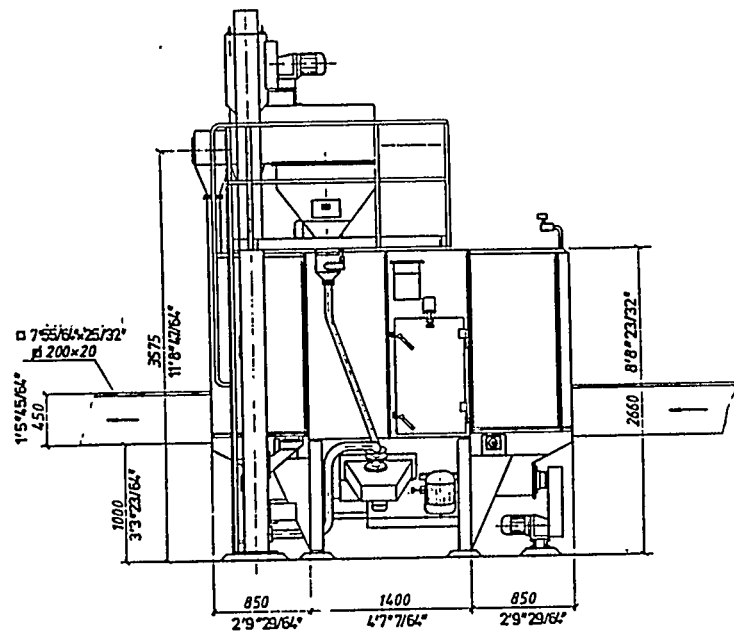
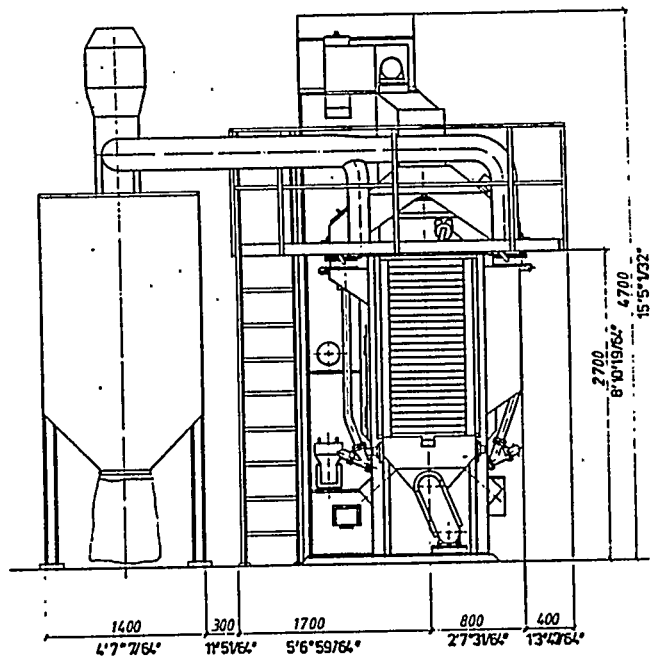
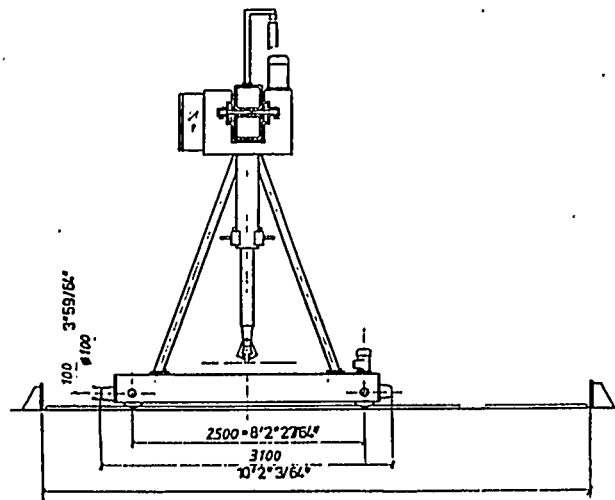
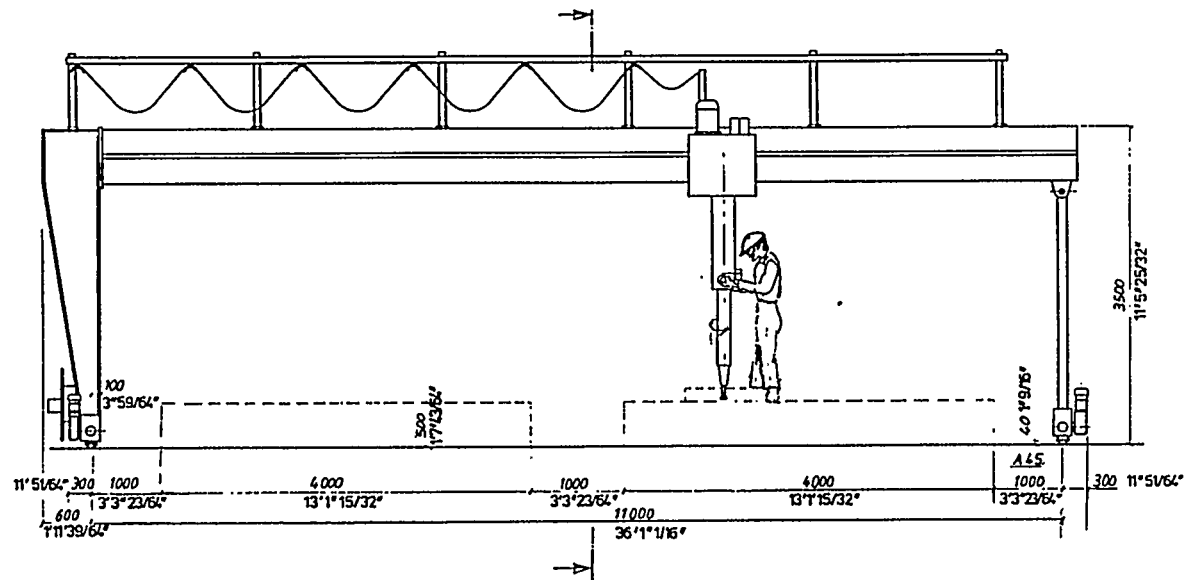


FIGURE: 3.







STATION:

X

I A B II C IV

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10000 (31'3")

4000 (121'3")
12500 (41'3")

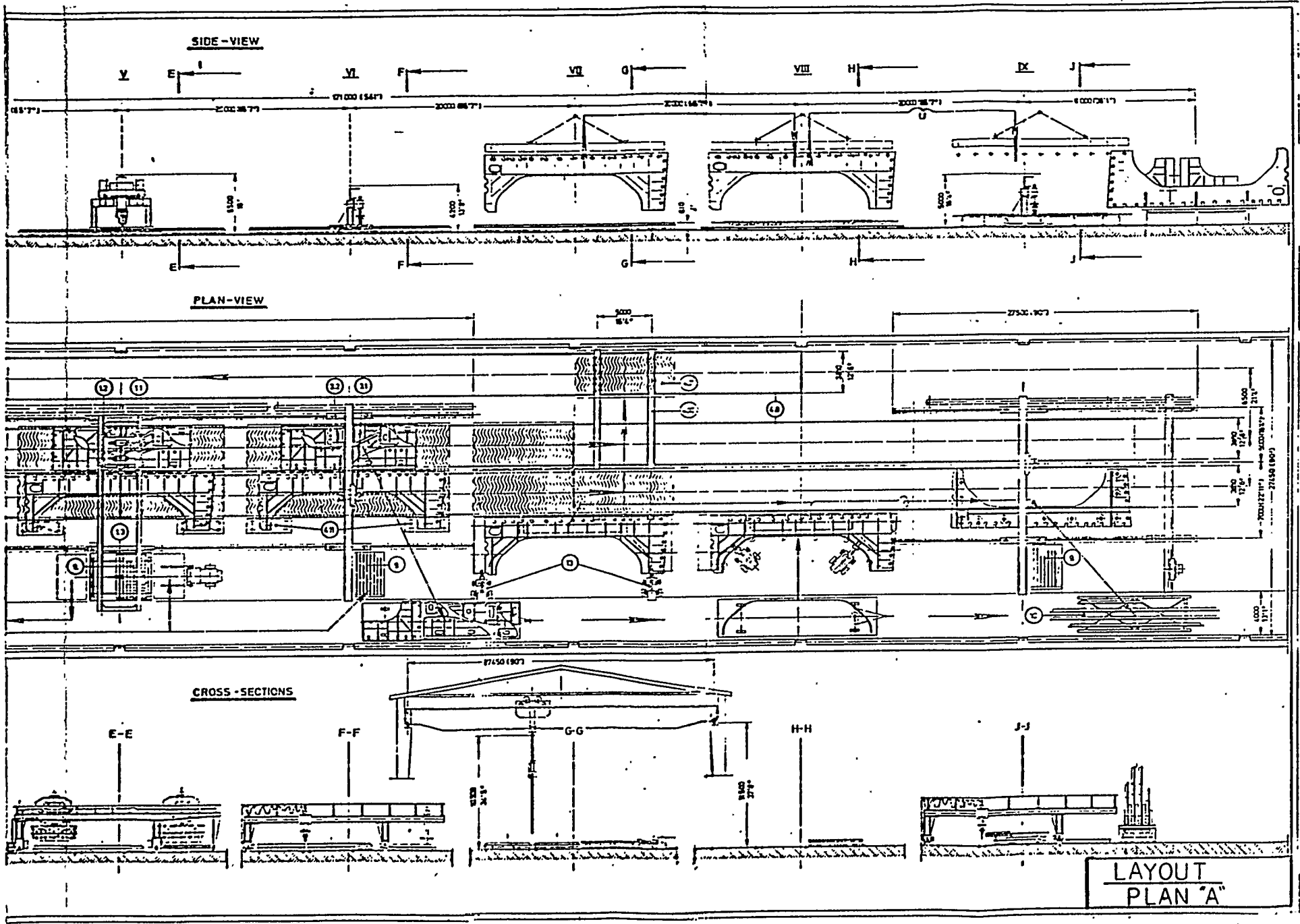
10000 (31'3")

A-A

B-B

C-C

D-D



2.20 EQUIPMENT SPECIFICATIONS

Pos . 1.1 POSITIONING MACHINE (SEE DRAWING # 763.06351-B)

TECHNICAL DATA

SPEED OF PORTAL 65 FT./16 FT./8 IN. PER MIN.

SPEED OF TROLLEY 65 FT/16 FT./8. IN. PER MIN.

ROTATION SPEED CORRESPONDENCE TO
CIRCUMFERENCE WITH SPEEDS OF 65 FT./16 FT./8 IN. PER MIN.

AMOUNT OF PRESSURE MAXIMUM 5 TONS

METHOD OF WELDING CORED WIRE

NUMBER OF WELDING- UNITS 2, EACH WITH 2 TORCHES

MAIN ELECTRICAL SUPPLY VIA TRAILING CABLE

INSTALLED POWER 120. KVA

WEIGHT APPROX. 15 TONS

WHEEL PRESSURE APPROX. 6 TONS

Pos. 1.2 CORED WIRE WELDING MACHINE

TECHNICAL DATA

CURRENT FOR WELDING 80 - 400 AMPS.

OPEN CIRCUIT VOLTAGE 17 -30 VOLTS

WIRE FEED SPEED 6 FT. - 60 FT. PER MIN.

-TYPE OF WELDING WIRE-USED 1/16TH IN. CORED

Pos. 1.3 DISPLACEMENT DEVICE FOR BEAM PALLETS

TECHNICAL DATA

MEASUREMENTS OF CARRIAGE:

LENGTH 14 FT.

WIDTH 9 FT.

HEIGHT 1 FT.

STEP DISTANCE 12 OF 8 IN.

Pos. 2.1 SHOT BLASTER FOR BEAMS (SEE DRAWING # 763.06359-B)

TECHNICAL DESCRIPTION

PASS-THROUGH SPEEDS FOR DEGREES OF CLEANING OF SA 2.5	6 FT. TO 25 FT. -PER MINUTE
INSTALLED POWER	30 KVA

POS. 2.3 CROSS TRANSFER FOR BEAM PALLETS

TECHNICAL DATA

WIDTH OF CHAIN TRACK	10 FT.
LENGTH OF CHAIN TRACK	25 FT.
CHAIN SPACING	10 FT.
WIDTH OF CHAIN	5 IN.
HEIGHT ABOVE FLOOR	1 FT.
TRAVEL DISTANCE	20 FT.
STEP DISTANCE	8 IN.
INSTALLED POWER	2 KW

pose 2.4 CONTROL SYSTEM AND ELECTRONICS

TECHNICAL DATA

ALL WIRING FOR ELECTRICITY AND FOR THE CONTROL SYSTEM IS
INSTALLED IN MULTIPLE DUCTS AND COVERED. THE WIRING HAS
BOLTED CONNECTIONS WHICH ARE BOTH WATER AND DUST TIGHT.

WEIGHT	1.2 TONS
INSTALLED POWER	40 KVA

Pos. 3.1 BEAM MANIPULATOR

(SEE DRAWING # 763.06363-B)

TECHNICAL DATA

TRACK WIDTH	33 FT.
PORTAL WIDTH	48 FT.
WORKING WIDTH	42 FT.
PORTAL PASSAGE HEIGHT	8 FT.
MAXIMUM CARRYING CAPACITY	1 TON
AVERAGE TRAVEL SPEED	1 FT. PER SECOND
CLAMPING FORCE OF GRIPPER	2 TONS
MAXIMUM OPENING OF HAND	8 IN.
MAXIMUM PRESSURE	2 TONS
WEIGHT APPROXIMATELY	7 TONS
MAXIMUM WHEEL PRESSURE	1.5 TONS
<u>INSTALLED POWER</u>	<u>5 KVA</u>

CURRENT IS SUPPLIED VIA CABLE ROLLERS AND A. TRAILING CABLE.

Pos. 4.1 TRANSPORT WAGON

TECHNICAL DATA

TRANSPORT WAGON MEASURES

28 FT. BY 13 FT.

Pos. 4.8 CONTROL AND ENERGY SUPPLY

TECHNICAL DATA

INSTALLED POWER 31 KVA

Pos. 5 FLAME CUTTING MACHINE

TECHNICAL DATA

WORKING WIDTH	30FT.
WORKING HEIGHT ABOVE FLOOR	2FT. 6 IN.
WORKING LENGTH	55 FT.
WIDTH OF TRACK	3 FT.
LENGTH OF TRACK	80 FT.

NC-CONTROLLED BURNER HEADS WORK IN MIRROR-SYMMETRY. CASSETTE CONTAINING DATA, PUNCH TAPE, REMOTE TRANSMISSION, POWER SUPPLY VIA TRAILING CABLE AND/OR CABLE ROLL, DUST EXTRACTOR, OPERATING PANEL ETC. CAPACITY FOR WORKING PIECES OF MILD STEEL WITH A THICKNESS OF 1/4 IN. TO 1 IN.

Pos. 9 BEAM PALLET

TECHNICAL DATA

LENGTH OF PALLET	13 FT.
WIDTH OF PALLET	8 FT. 2 IN.
NUMBER OF SEPARATED ROWS	12 IN.
SEPARATOR HEIGHT	5 IN.
SPACE BETWEEN SEPARATORS	4 IN.
WEIGHT	1.25 TONS
LOAD CAPACITY	5 TONS

Pos. 10 WEB PALLET

TECHNICAL DATA

PALLET LENGTH	33 FT. 8 IN.
WEB PALLET WIDTH	10 FT. 6 IN.
HEIGHT OF PALLET BASE	5 FT. 6 IN.
HEIGHT OF SEPARATORS	12 FT.
NUMBER OF SEPARATORS	4
SPACE BETWEEN SEPARATORS	2 FT. 4 IN.
MAXIMUM WEB LENGTH	54 FT.
MAXIMUM WEB WIDTH	AS REQUIRED
MAXIMUM LOAD CAPACITY	50 TONS

2.21 CYCLE TIME OF MACHINES

2.21.1 CYCLE TIME FOR BEAM POSITIONING AND ."
WELDING MACHINE, POS. 1

WHEN ONE BEAM IS TO BE POSITIONED AND WELDED, WITH AN AVERAGE LENGTH OF 6 FT., WITH NOMINAL SEAM THICKNESS OF 3/16TH IN., AND WITH A DEPOSIT RATE OF 10.8 POUNDS PER HOUR, AND A WELDING SPEED OF 20 IN. PER MIN., AND USING 4 BURNERS, THEN :

TOTAL TRAVEL TIME	83 SEC.
TOTAL NON-PRODUCTIVE TIME	52 SEC.
TOTAL WELDING TIME	111 SEC.
PALLET TIME	3 SEC.
TOTAL FOR 1 BEAM	249 SEC.

THEREFORE, CYCLE TIME FOR THREE BEAMS EQUALS 747 SECONDS OR 12.45 MINUTES.

2.21.2 CYCLE TIME FOR BEAM CLEANING UNIT, POS. 2.

THE CLEANING MACHINE IS ONLY USED FOR BEAMS LONGER THAN 3 FT. MOREOVER THREE BEAMS. WITH A TOTAL LENGTH OF 18 FT. ARE REQUIRED PER REFERENCE WEB. THIS MEANS THAT THE ABOVE LENGTH IS PROCESSED BY THE MACHINE AT A SPEED OF BETWEEN 6 FT. AND 24 FT. PER MINUTE OR AN AVERAGE OF ABOUT 12 FT. PER MINUTE. IT THEREFORE TAKES THE MACHINE ABOUT 1.5 MINUTES TO COMPLETE THE CLEANING OF THREE BEAMS, AFTER WHICH THEY ARE DELIVERED TO THE POSITIONING MACHINE. A CLEAN BEAM IS DELIVERED EVERY 0.5 MINUTES, BUT THE POSITIONING MACHINE CAN ONLY ACCEPT DELIVERY EVERY 4.15 MINUTES. IT IS THEREFORE NECESSARY TO INSTALL A SUFFER AND THE UNIT ONLY HAS TO WORK AT APPROXIMATELY 12 PERCENT OF CAPACITY.

2.21.3 CYCLE TIME FOR MANIPULATOR, POS. 3.

REMOVE BEAM FROM BEAM PALLET	10 SEC.
GUIDE BEAM TO JOINT WELDING POSITION	20 SEC.
LOWER BEAM MANUALLY INTO FISSURE AND PRESS INTO FISSURE	15 SEC.
" BRING WELDING DEVICE AND ELECTRODE PIN C E R S INTO START POSITION	10 SEC.
WELD TWO AVERAGE LENGTH FILLET WELDS	352 SEC.
. INSPECT- SEAM AND REMOVE SLAG	30 SEC.
BRING GRIPPING PLIERS INTO START POSITION	<u>12 SEC.</u>
SUE- TOTAL FOR ONE BEAM	450 SEC.
(SECOND BEAM SAME TIME)	450 SEC.
FINAL SEAMS PLUS ADDITIONAL TIME	480 SEC.
I NSPECTION AND REMOVAL OF SLAG	<u>120 SEC.</u>
TOTAL	1,500 SEC. OR 25 MIN.

2:21.4 CYCLE TIME AND REQUIRED PERFORMANCE FOR FLAME-
CUTTING HEAD WITH TWO TORCHES.

TAKING INTO ACCOUNT THE OPERA-TION TIME FOR THE POSITIONING AND WELDING MACHINE, 24.9 MINUTES REMAIN AVAILABLE FOR FLAME CUTTING OF TWO REFERENCE WEBS. THE REFERENCE WEB HAS A FLAME CUT LENGTH OF 23 FT. TWELVE REFERENCE WEBS CAN BE CUT FROM A PLATE MEASURING 13 FT. BY 54 FT. THE TIME FOR THE POSITIONING AND ADJUSTING IS EQUAL TO 10 MINUTES DIVIDED BY 12 WEBS OR A TOTAL OF 0.833 MINUTES PER WEB. OPERATING TIME FOR TRANSPORTING TABLES IS APPROXIMATELY 0.1 MINUTES PER WEB AND TORCH TRAVELING TIME TO AND FROM THE PLATE IS APPROXIMATELY 0.5 MINUTES.

THIS GIVES A SUB-TOTAL OF 1.43 MINUTES AND LEAVES THE REMAINING TIME AVAILABLE FOR FLAME CUTTING AT 24.9 MINUTES.

IT IS THEREFORE NECESSARY TO SELECT A METHOD OF CUTTING WHICH ALLOWS FOR AN AVERAGE SPEED OF 9 AND 1/2 IN. PER MINUTE, . USING A CUT PLATE WITH AN AVERAGE THICKNESS OF 3/4 IN. THE FOLLOWING FIGURES GIVE A ROUGH GUIDE FOR 3/4 IN. THICK MILD STEEL .

ACETYLENE - OXYGEN	11 IN. TO 14 IN. PER MIN.
PLASMA	16 IN. TO 26 IN. PER MIN.

2.21.5 CYCLE TIME FOR-BEAM PALLETS

- BEAM PALLETS WITH THE FOLLOWING MEASUREMENTS SERVE AS BUFFERS.

LENGTH	13 FT.
WIDTH	8 FT.
BEAM DISTANCE IN PALLET	8 IN.
CAPACITY	12 BEAMS

BASED ON THE ABOVE, A REFERENCE BEAM MUST RECEIVE A SUPPLY OF BEAMS AND A FULL BEAM PALLET MUST ARRIVE AND AN EMPTY ONE -RETURN EVERY 50 MINUTES. BEAM PALLETS FOR THE MANIPULATOR STATION CARRY APPROXIMATELY 48 SHORT BEAMS, SO THAT ONE PALLET EVERY FIVE HOURS IS REQUIRED. THUS EIGHT BEAM PALLET MOVEMENTS ARE NECESSARY, WITH EACH LASTING FIVE MINUTES. THE WORK LOAD CAPACITY OF THE TRANSPORT SYSTEM FOR THE FORK TRUCK MOVING BEAM PALLETS IS ONLY 20 PERCENT.

2. 22

DATA ON WORK PIECES

DESCRIPTION	REFERENCE WEB (1 PIECE)	LARGE WEB (1 PIECE)
LENGTH OF PLATES	8 FT.	54 FT.
WIDTH OF BASIC PLATES	5.58 FT.	18 FT.
THICKNESS OF BASIC PLATES	0.50 IN.	1 IN.
NUMBER OF NECESSARY PLATES	1/12 PC.	1.75 PC.
LENGTH CUT		49 FT.
LENGTH OF SUB-ARC WELD, TOP SIDE	----	39 FT.
OVERALL MARKING LENGTH	22 FT.	148 FT.
OVERALL CUT LENGTH	38 FT.	182 FT.
AUTOMATIC POSITIONED BEAMS	3	25
LENGTH OF AUTOMATIC WELD BEAMS	34 FT.	118 FT.
MANUAL POSITIONED BEAMS	2	14
LENGTH OF WELD MANUAL POSITIONED BEAMS	4 FT.	36 FT.
NUMBER OF FINAL WELDS	10	64
NUMBER OF VERTICAL WELDS	2	18
FACE PLATE LENGTH-	----	5.3 FT.
FACE PLATE WELD LENGTH	-----	106 FT.
SUB-ARC WELD, BACK SIDE	----	39 FT.
NUMBER OF BEAMS BACK SIDE	----	5
WELD LENGTH BEAMS BACK SIDE	----	119 FT.
TOTAL WEIGHT	0.50 TONS	16 TONS

2.23 . REFERENCE WEB (SEE FIGURE 3)

FOR THE TIME AND THROUGHPUT STUDY IT WAS NECESSARY TO USE A WEB WHICH IS REPRESENTATIVE OF PRODUCTION. THE FINDINGS ON THE REFERENCE WEB ARE BASED ON THE FOLLOWING ASSUMPTIONS: 70 PERCENT ARE SMALL WEBS APPROXIMATELY 6 FT. BY 3 FT. WITH ONE BEAM 5 FT. LONG; 25-PERCENT ARE MEDIUM WEBS MEASURING 11 FT. BY 17 FT. WITH 10 POSITIONED BEAMS BETWEEN 2 FT. AND 13 FT.; AND 5 PERCENT ARE LARGE WEBS 17 FT. BY 54 FT., WITH 34 POSITIONED SEAMS AVERAGING BETWEEN 2 FT. AND 13 FT. EACH.

ON AN AVERAGE, 100 WEBS HAVE 490 POSITIONED BEAMS RANGING FROM 2 FT. TO 13 FT. OF THESE APPROXIMATELY 60 PERCENT ARE LONGER THAN 3 FT. AND CAN BE POSITIONED AUTOMATICALLY (SEE FIGURE 3). FROM THE ABOVE DATA IT FOLLOWS THAT A REFERENCE WEB AS SHOWN IN FIGURE 4 IN THE SECTION IMMEDIATELY FOLLOWING THIS ONE WOULD HAVE A LENGTH OF APPROXIMATELY 8 FT. A WIDTH OF 6 FT. 6 IN. AND BE OF PLATE $3/4$ IN. THICK WEIGHING 1,200 LBS. THE WELDING SEAM RADIUS WILL BE AN AVERAGE OF $3/16$ TH IN. 3 POSITIONED BEAMS WITH AN AVERAGE LENGTH OF 6 FT. WILL BE REQUIRED FOR AUTOMATIC POSITIONING, AND 2 POSITIONED BEAMS; SHORTER THAN 3 FT., FOR POSITIONING WITH THE MANIPULATOR WILL BE REQUIRED. THE AVERAGE BEAM THICKNESS IS $1/2$ IN. AND THE AVERAGE BEAM HEIGHT IS 8 IN. IN ADDITION TO THE ABOVE, THERE ARE 8 FINAL SEAMS OF 2 IN. EACH. AN AVERAGE FLAME CUT LENGTH OF 22 FT. IS REQUIRED FOR A REFERENCE BEAM. IT THEREFORE FOLLOWS THAT THE RELATION OF WELDING SEAM LENGTH TO FLAME CUT LENGTH IS A RATIO OF APPROXIMATELY 1 TO 2.2.

FIGURE : 4

REFERENCE
WEB-SIZE

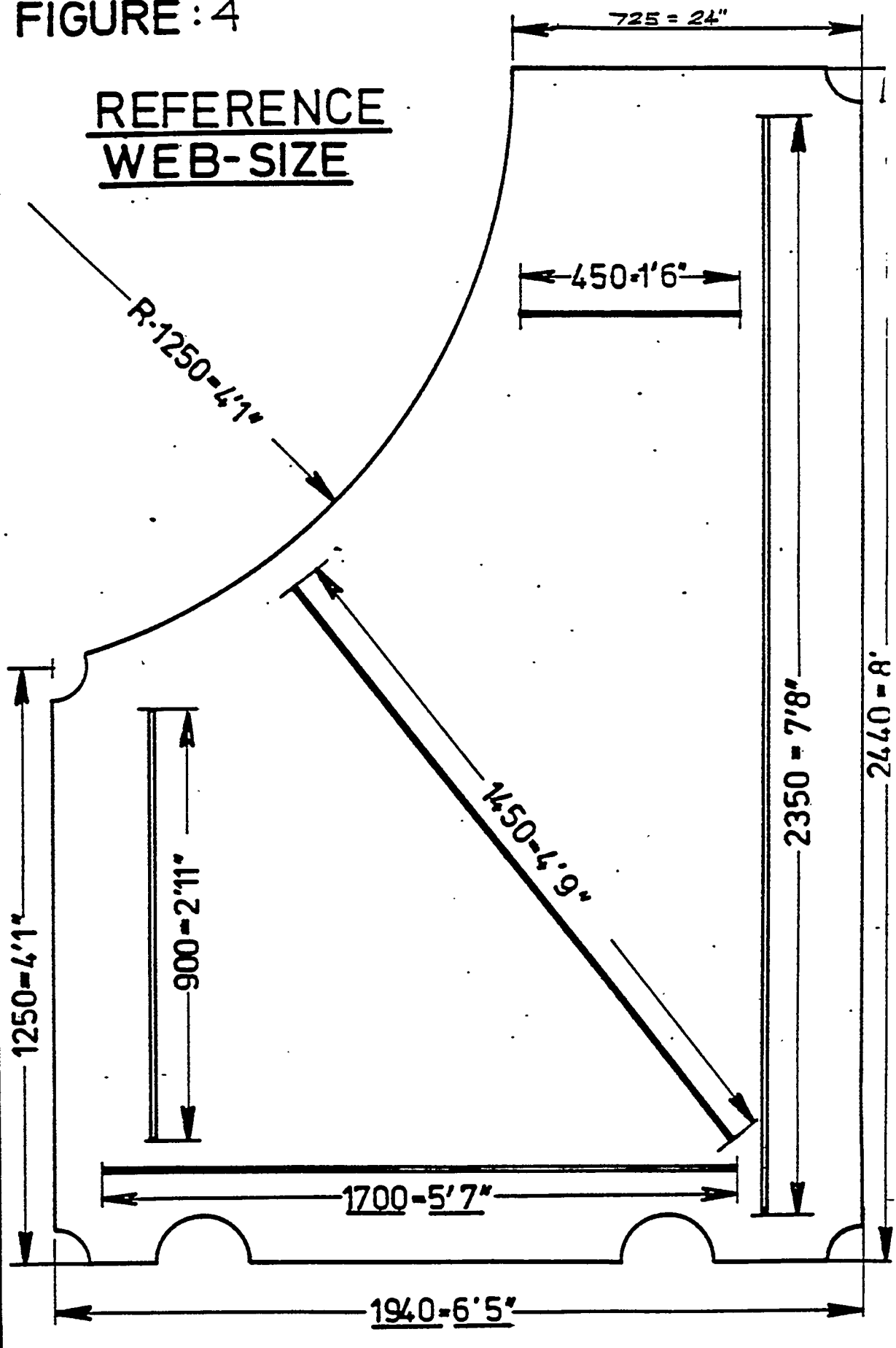
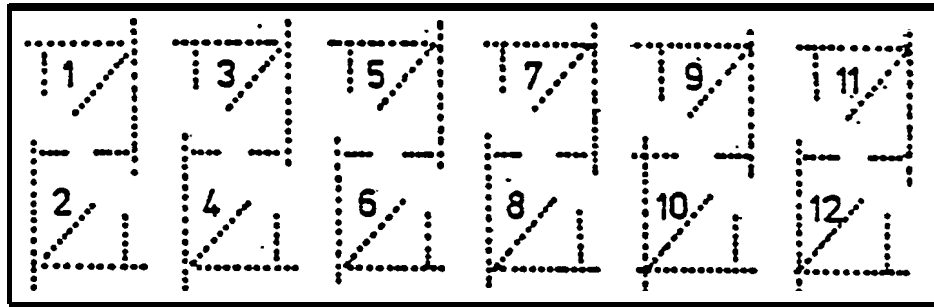
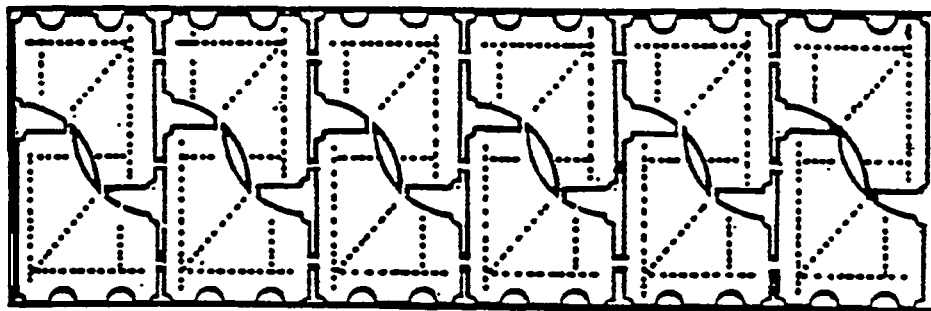


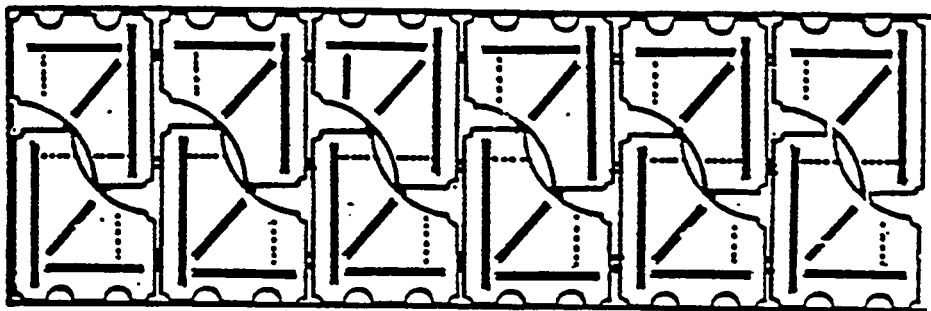
FIG : 5



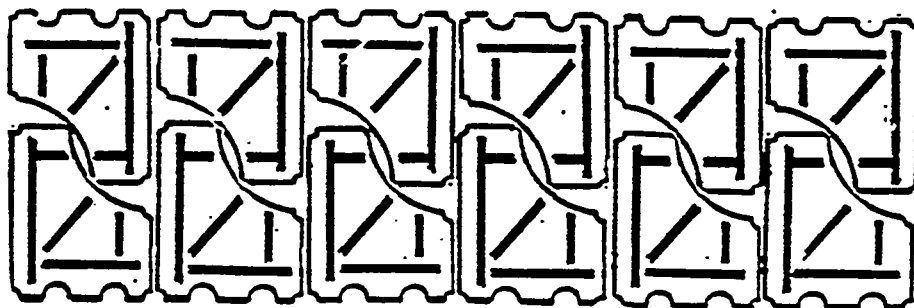
1. Marking and Labeling



2. Contour Cutting



3. Automated Handling, Positioning and Welding of Profiles.



4. Manual Adding of Profiles and Finishing.

TYPICAL WEB SIZES and REFERENCE WEB SIZE

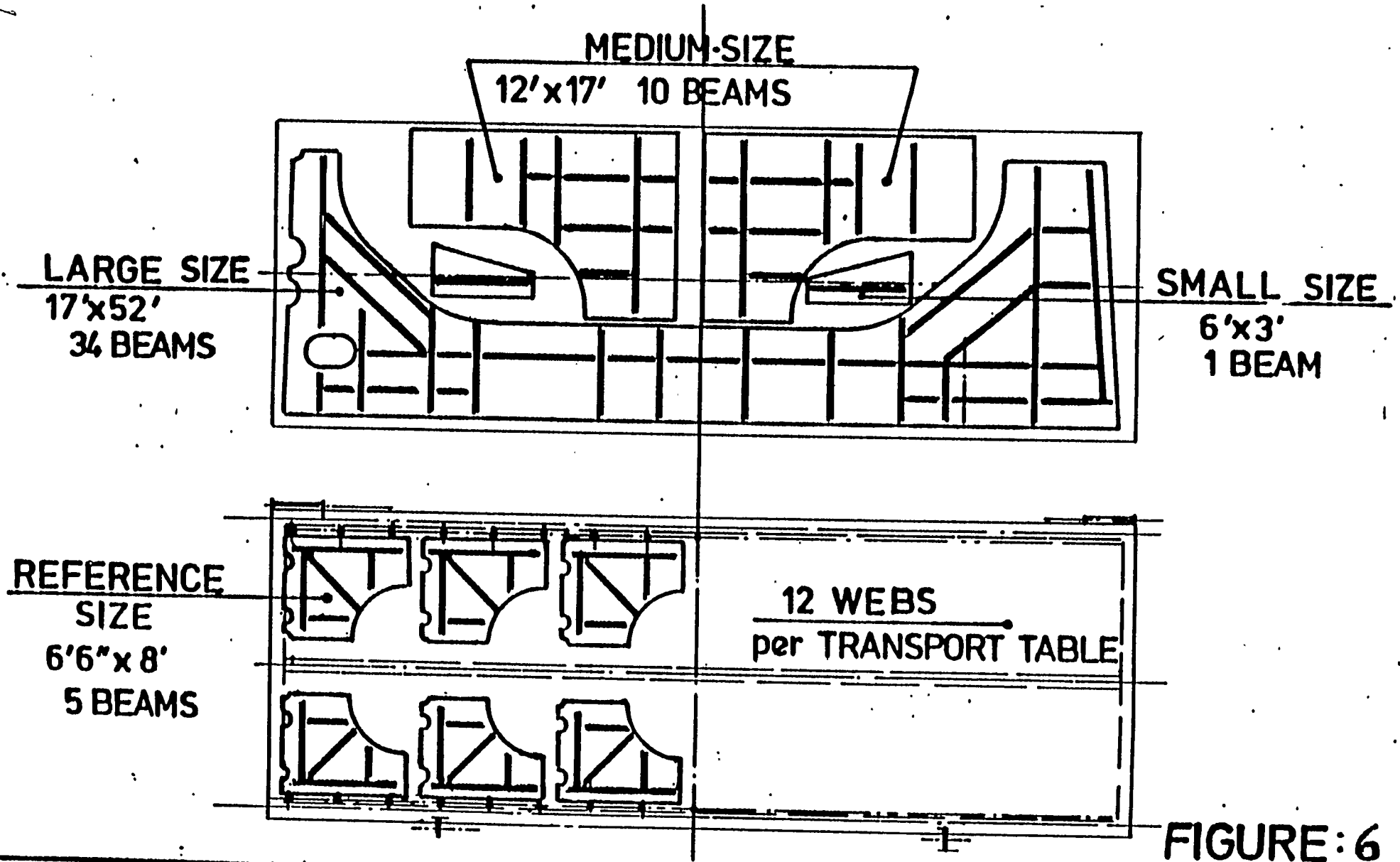
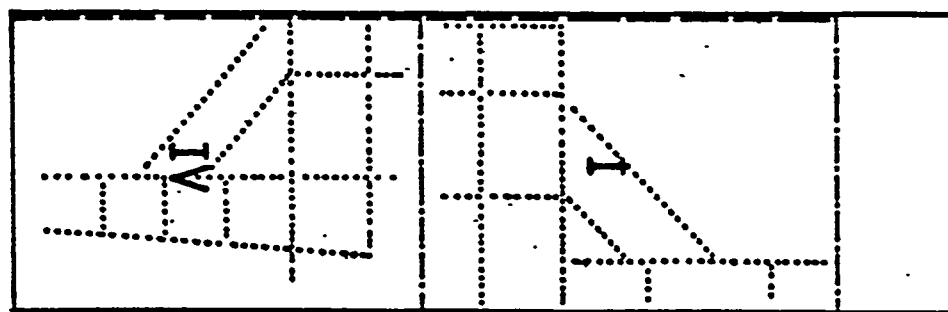
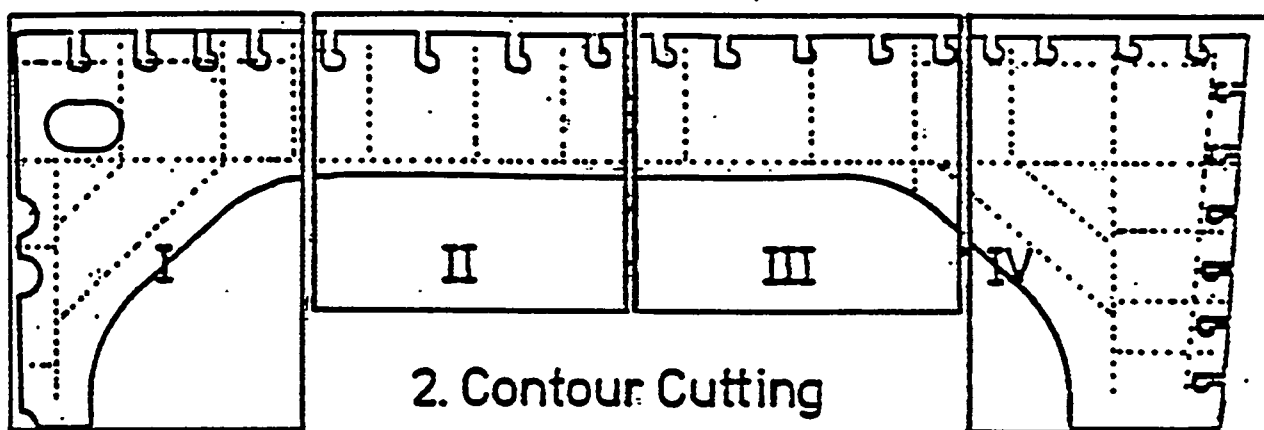
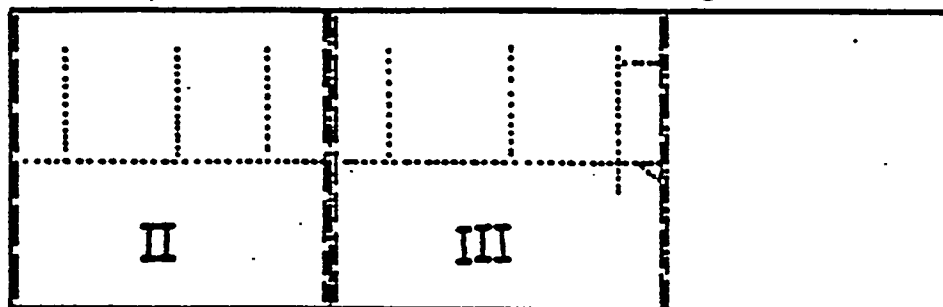


FIGURE: 6

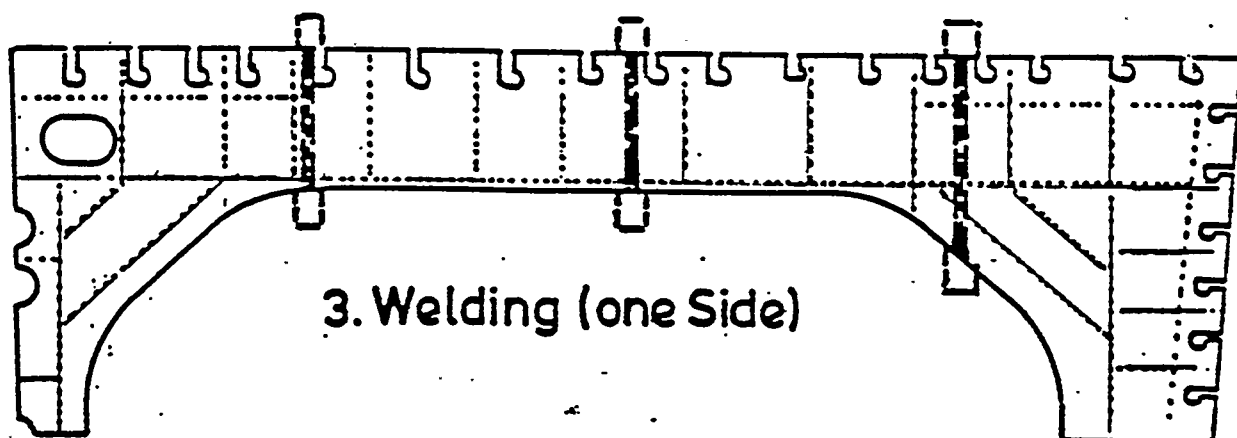
FIG: 7



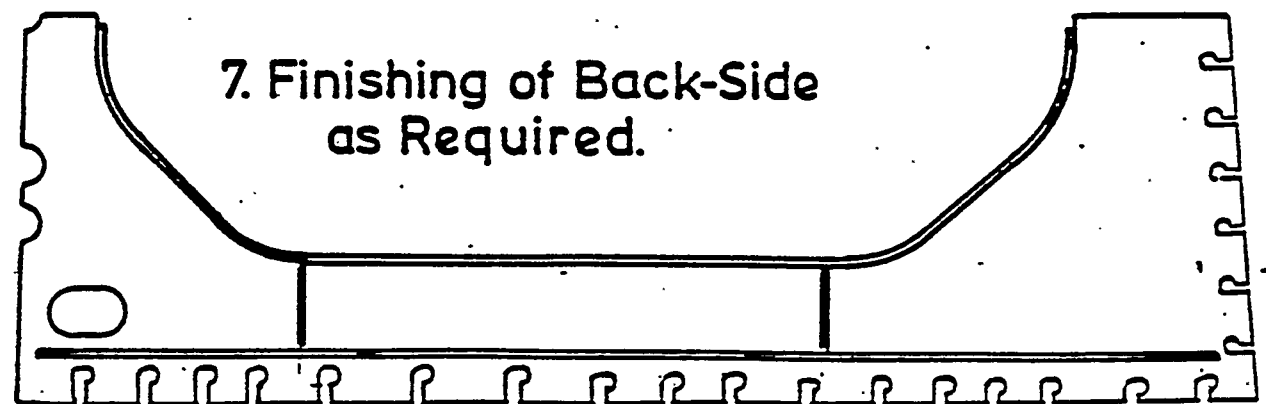
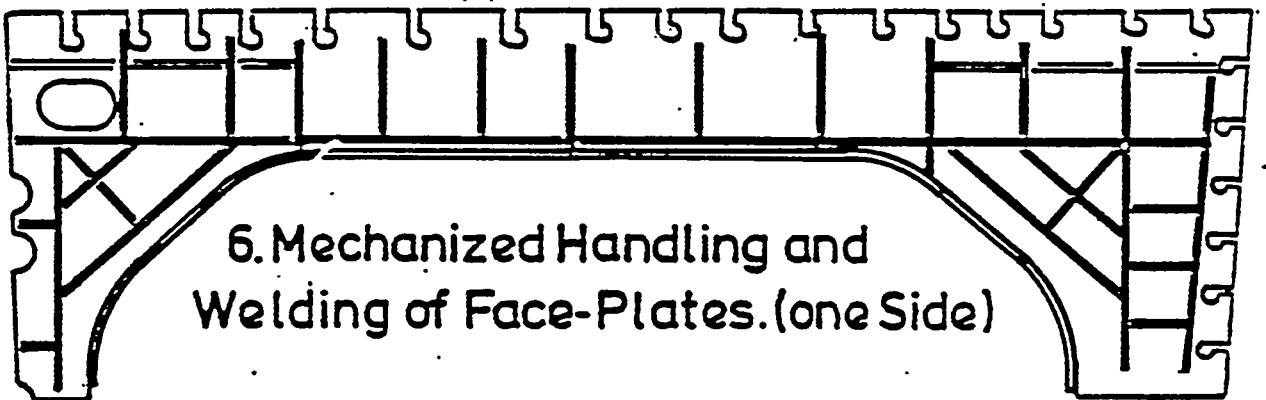
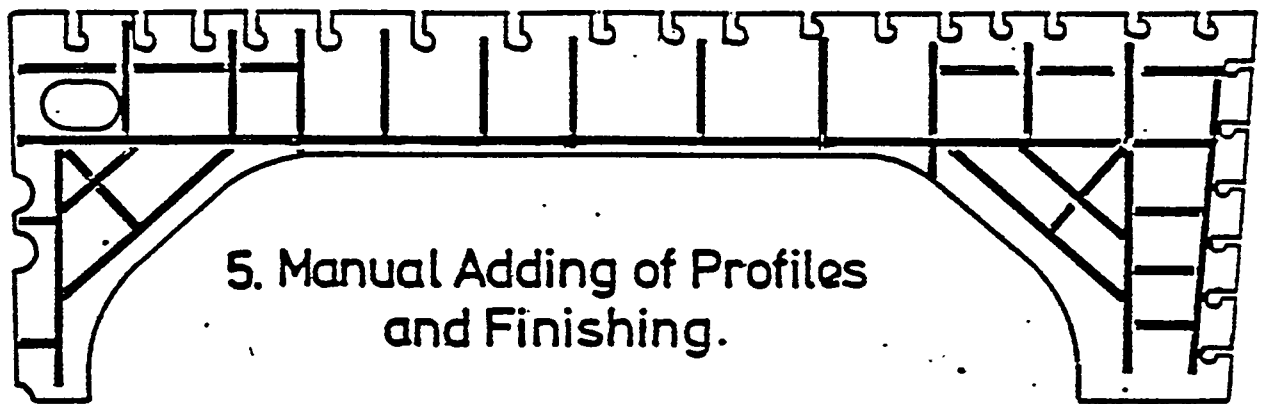
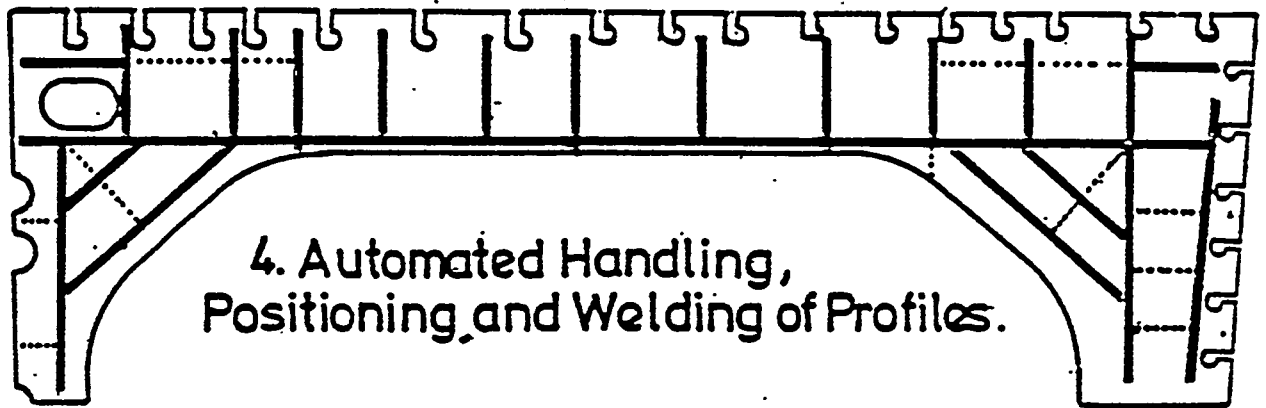
1. Marking, Labeling, and Cutting



2. Contour Cutting



3. Welding (one Side)



2. 24

COMPARISON OF OPERATING TIMES STATION I - X PER WEB

STATION OPERATION		REFERENCE WEB	LARGE WEB
I	MAKING TRANSPORT TABLE AVAILABLE AND LOADING	2 MIN.	40 MIN.
II	MARKING, LABELING, AND WELD PREPARATION	4 MIN.	150 MIN.
III	CONTOUR CUTTING	10 MIN.	155 MIN.
IV	SUB-ARC WELDING	--	125 MIN.
V	AUTOMATIC BEAM POSITIONING AND WELDING	12.5 MIN.	80 MIN.
VI	MANUAL BEAM POSITIONING AND WELDING (2 MEN)	12.5 MIN.	140 MIN.
VII	OFF-LOADING/FACE PLATE TACKING (2 MEN)	3 MIN.	150 MIN.
VIII	FACE PLATE WELDING, TOP (2 MEN)	----	150 MIN.
IX	HEAT STRAIGHTENING, FACE PLATE WELDING BACK SIDE, BEAM TACKING AND WELDING (3 MEN)	----	150 MIN.
X	BEAM CLEANING	2 MIN.	25 MIN.

24 REFERENCE WEBS OR ONE LARGE WEB CAN BE FABRICATED FROM TWO LARGE PLATES. THE CYCLE TIME IS 310 MINUTES FOR 24 REFERENCE WEBS AND 165 MINUTES FOR ONE LARGE WEB.

2.25 ESTIMATED PERSONNEL REQUIREMENTS AT THE INDIVIDUAL
STATIONS FOR REFERENCE AND LARGE WEB FABRICATION

<u>STATION OPERATION</u>		<u>MEN FOR REFERENCE WEB</u>	<u>MEN FOR LARGE WEB</u>
I	MAKING TRANSPORT TABLE AVAILABLE AND LOADING	0.25	0.25
II	MARKING, LABELING, AND WELD PREPARATION	0.25	0.75
III	CONTOUR CUTTING	0.50	0.25
IV	SUB-ARC WELDING	---	2.0
V	AUTOMATIC BEAM POSITIONING. AND WELDING	1.0	1.0
VI	MANUAL BEAM POSITIONING AND WELDING (2 MEN)	2.0	2.0
VII	OFF-LOADING/FACE PLATE TACKING (2 MEN)	0.75	2.0
VIII	FACE PLATE WELDING, TOP	----	2.0
IX	HEAT STRAIGHTENING, FACE PLATE WELDING BACK SIDE, BEAM TACKING AND WELDING		3.0
X	AUTOMATIC BEAM CLEANING	0.25	0.25
	CRANE OPERATION	0.5	0.5
	PALLET TRANSPORT AND UNSKILLED LABOR	1.0	1.0
	FOREMAN AND SHOP SUPERVISION	0.25	0.25
	TOTALS	6.75	16.25

FROM THE ABOVE CYCLE TIMES OF 310 MINUTES AND 165 MINUTES
 RESPECTIVELY FOR THE REFERENCE AND LARGE WEBS, THE MAN HOURS
 REQUIRED ARE AS FOLLOWS:

REFERENCE WEB	1.45 MAN-HOURS
LARGE WEB	45 MAN-HOURS

2. 26 STEEL THROUGHPUT

ON THE BASIS OF THE PROCESS FLOW RATE DEFINED IN THIS STUDY AN HOURLY STEEL THROUGHPUT OF 5 TONS CAN BE EXPECTED. THIS IS EQUIVALENT TO 16,000 TONS PER YEAR AT 3,300 EFFECTIVE WORKING HOURS, AND TWO SHIFTS.

A 40,000 METRIC TON BULK CARRIER WITH AN ESTIMATED STEEL WEIGHT OF APPROXIMATELY-9,000 TONS FOR THE HULL CONTAINS APPROXIMATELY 35 PERCENT OR 3,150 TONS OF WEBS. THUS THE SYSTEM HAS A CAPACITY TO PRODUCE WEBS FOR ABOUT FIVE 40,000-TON BULK CARRIERS (ON 2 SHIFTS). SHOULD THERE BE A HIGHER REQUIREMENT; THE CONTOUR CUTTING FOR THE FABRICATION OF LARGE WEBS COULD BE ACCELERATED BY EMPLOYING A WATER PLASMA UNIT. DURING THE FABRICATION OF SMALL AND MEDIUM WEBS, THE BOTTLE-NECK WOULD BE IN THE AUTOMATIC BEAM POSITIONING AND WELDING MACHINE. THIS OPERATION COULD BE INCREASED IF THE ROBOT STATIONS ARE BROKEN DOWN INTO A POSITIONING AND TACKING STATION, FOLLOWED BY FULLY AUTOMATIC FINISH WELDING STATIONS. A REDUCTION IN THE SPACE REQUIREMENT FOR THE OVERALL PLANT CAN BE ATTAINED IF FLOW TRANSPORT FOR LARGE WEBS IS REPLACED BY STATIONARY WORK STATIONS.

2. 27 EQUIPMENT INSTALLATION PLAN

PROVIDED THAT ALL NECESSARY SITE PREPARATIONS HAVE BEEN FULFILLED AT THE DATE OF DELIVERY, AND PROVIDED THAT SUFFICIENT NUMBERS OF CRAFTSMEN, ELECTRICIANS AND OTHER WORKERS ARE AVAILABLE TO SUPPORT THE SUPERVISION, THE FOLLOWING MAN-HOURS AND WORKING WEEKS CAN BE ASSUMED (FOR A TEAM OF THREE ENGINEERS, WORKING A ONE SHIFT SYSTEM):

POSITION	MAN HOURS	TEAM WEEKS	SIZE OF TEAM
POS. 1 BEAM POSITIONING AND WELDING MACHINE	720	6	3
Pos. 2 SHOT BLASTER FOR BEAMS	480	4	3
Pos. 3 BEAM MANIPULATOR	360	3	3
Pos. 4 TRANSPORT SYSTEM FOR TRANSPORT TABLES	480	4	3
Pos. 5 TORCH CUTTING UNIT	160	2	2
Pos. 7 TO 10 ACCESSORIES	80	1	2

THUS IT WOULD REQUIRE 17 TO 20 WEEKS, OR APPROXIMATELY 4 MONTHS. AN ADDITIONAL 4 WEEKS WOULD BE REQUIRED FOR TESTING, INSTRUCTION AND STAFF TRAINING, PROVIDED THAT SAMPLE WORK PIECES AND PRODUCTION MATERIALS ARE AVAILABLE IN SUFFICIENT QUANTITY.

2. 28 SCALE MODEL OF THE PROPOSED FACILITY

A SCALE MODEL ON A SCALE OF 1:50 WAS CONSTRUCTED. SEE PHOTOGRAPHS IN SECTION NUMBER 2.19.

ITEMS THAT REQUIRE PROTOTYPES DEVELOPED AND DEMONSTRATED
UNDER SIMULATED OR ACTUAL PRODUCTION CONDITIONS

OF ALL OF THE POSITIONS WHICH ARE PROPOSED FOR A COMPLETE WEB LINE, THE BEAM POSITIONING AND WELDING MACHINE, POS. 1, IS THE ONLY PROTOTYPE TO BE DEVELOPED. SOME MECHANICAL ELEMENTS OF THE MACHINE SUCH AS MAGNET GRIPPERS. PRESSURE BAR AND WELDING UNIT EXIST ON PANEL PRODUCTION LINES. THE CONTROL SYSTEM HAS TO BE DEVELOPED AS-WELL AS SOME OF ITS FEATURES WHICH MAY BE A PROTOTYPE. GENERALLY THERE ARE THREE KINDS OF CONTROLS SUITABLE FOR THIS TASK:

- | PUSH- BUTTON CONTROL AND VISUAL POSITIONING OF BEAMS.
IN THIS CASE ALL LOCATIONS OF BEAMS HAVE TO BE MARKED ON CUT PLATES BY POWDER MARKING.
- | AUTOMATED CONTROL BY THE AID OF CAD-DEVELOPED STORED DATA IN CONJUNCTION WITH DEFINED LOCATION-OF CUT PLATES. (THIS APPLIES ONLY TO PLAN A AND PLAN B.)
- . AUTOMATED CONTROL BY THE AID OF CAD- DEVELOPED STORED DATA IN CONJUNCTION WITH A SYSTEM "FINDING THE PRECISE LOCATION OF EACH CUT PLATE AND CORRESPONDING PROGRAM SHIFTING. DEFINING OF CUT PLATE LOCATION CAN BE ACCOMPLISHED SIMPLY BY PLACING THE WORK PIECE IN Y - DIRECTION BY STOPPERS AND OPTICAL SENSING OF THE ACTUAL X - POSITION. THE SENSOR IS FIXED TO THE PORTAL AND GIVES THE ORIENTATION FOR DATA SHIFTING. ALL ABOVE SOLUTIONS HAVE ALREADY-BEEN PARTLY USED IN ROBOTS AND OTHER MACHINES.

2.30 . EVALUATION OF ACTUAL WELDING SPEEDS DEPENDING ON DIFFERENT SURFACE CONDITIONS

OUR OWN WELDING TESTS HAVE SHOWN THAT THE METHOD OF WELDING APPLIED, AND THE SPEEDS THAT CAN BE ACHIEVED, DEPEND ON THE CONDITION OF THE SURFACE OF THE PLATES TO BE WELDED AND TYPE AND THICKNESS OF THE SHOP PRIMER USED.

IN VARIOUS TESTS IT WAS PROVED THAT SUBMERGED-ARC WELDING CREATES MORE POROSITY THAN SHIELDED GAS AND CORED WIRE WELDING. ON THE OTHER HAND WELDING SPEED OF SUBMERGED-ARC WELDING IS SUPERIOR. NEVERTHELESS, SUBMERGED-ARC WELDING CANNOT BE APPLIED IN THIS CASE BECAUSE THE FLUX CANNOT BE KEPT IN POSITION WHEN WELDS HAVE TO BE MADE ALONG THE EDGES.

FURTHER INVESTIGATION OF SUBMERGED-ARC WELDING THEREFORE WAS ABANDONED AND ONLY SHIELDED GAS AND CORED WIRE WELDING WERE CONSIDERED.

"THE WELDING RESEARCH INSTITUTE" DUISBURG, IS THE LEADING INSTITUTE IN GERMANY IN REGARD TO INVESTIGATIONS OF THE INFLUENCE OF SHOP PRIMERS ON POROSITY DURING WELDING. IN COOPERATION WITH THE INSTITUTE, THE SHOP PRIMER RECEIVED FROM ASI WAS TESTED AND THE FOLLOWING INVESTIGATIONS WERE PERFORMED:

* INVESTIGATION OF ASI'S SHOP PRIMER ACCORDING TO DVS STANDARD 0501.

INVESTIGATION OF POROSITY BY WELDING IN CONJUNCTION WITH THE SHOP PRIMER FROM ASI UNDER DIFFERENT WELDING CONDITIONS. (ASI ALSO PROVIDED THE WIRES).

BOTH OFFICIAL REPORTS IN ENGLISH TRANSLATION ARE INCLUDED IN THE APPENDIX TOGETHER WITH RELATED LITERATURE. IN ACCORDANCE WITH REPORT 8434013, THE AVERAGE AREA OF POROSITY OF THE ASI PRIMER AMOUNTS TO 71 MM². THIS PRIMER IN PRINCIPLE IS ACCEPTABLE IF NO HIGH-SPEED WELDING IS REQUIRED. IN ACCORDANCE WITH REPORT # 8439025, A WELDING SPEED OF ONE FT. PER MINUTE IS ACHIEVABLE WITH CORED WIRE OF 1/16TH IN., USING CLEANED BEAMS AND PRIMED CUT PLATES. IN CHECKING THE ACTUAL SITUATION WITH EUROPEAN SHIPYARDS, THE FLENSBURGER SCHIFFSVAUGESELLSCHAFT, FLENSBURG, A GERMAN SHIPYARD, HAS COLLECTED THE MOST ADVANCED EXPERIENCE WITH SHOP PRIMERS. AFTER LENGTHY AND SYSTEMATIC EXPERIMENTS, THIS COMPANY HAS REACHED THE FOLLOWING CONCLUSIONS:

METHOD OF WELDING CORED WIRE - WITH INERT GAS DIAMETER OF WIRE	1/16TH IN.
INERT GAS	40 % CO ₂ , 60% ARGON
TYPE OF WIRE	ARCOSARC 55
WELD RADIUS	9/64 IN. TO 7/32 IN.
SHOP PRIMER	CHEMULACK-PRIMER E.
THICKNESS OF COATING (1 U CORRESPONDS TO APPROX. 0.0254 IN.)	20 U ± 5 U
WELDING SPEED (ALL SURFACES PRIMED)	24 TO 28 IN. PER MIN.

ENCLOSED ARE THE REPORTS FROM THE "WELDING RESEARCH INSTITUTE" DUISBURG, ON THIS PRIMER TOGETHER WITH ACCEPTANCE CERTIFICATES OF DIFFERENT SHIPBUILDING CLASSIFICATIONS WITH ASI "PRIMER.

AS -PER REPORT # 7935104, THE AVERAGE AREA OF POROSITY OF CHEMULACK-PRIMER E AMOUNTS TO ONLY 6 MM². THE RESULTS OF TESTING DIFFERENT PRIMERS ARE INDICATED IN FIGURE 8. PRIMERS FROM ASI AND CHEMULACK ARE MARKED SPECIFICALLY. IN ORDER TO GAIN HIGH WELDING SPEED UNDER THE CREATION OF ACCEPTABLE PORES, U. S. SHIPYARDS SHOULD TRY TO FIND IMPROVED PRIMERS. THIS WOULD AFFECT THE THROUGHPUT AND THE WELD QUALITY CONSIDERABLY.

2. 31 THROUGHPUT

FOR ALL PROPOSALS A THRU E, THE THROUGHPUT IS DETERMINED BY THE BEAM' S POSITIONING AND WELDING MACHINE ONLY, POS. 1. THIS DEPENDS ON THE WELDING SPEED WHICH CAN BE ACHIEVED.

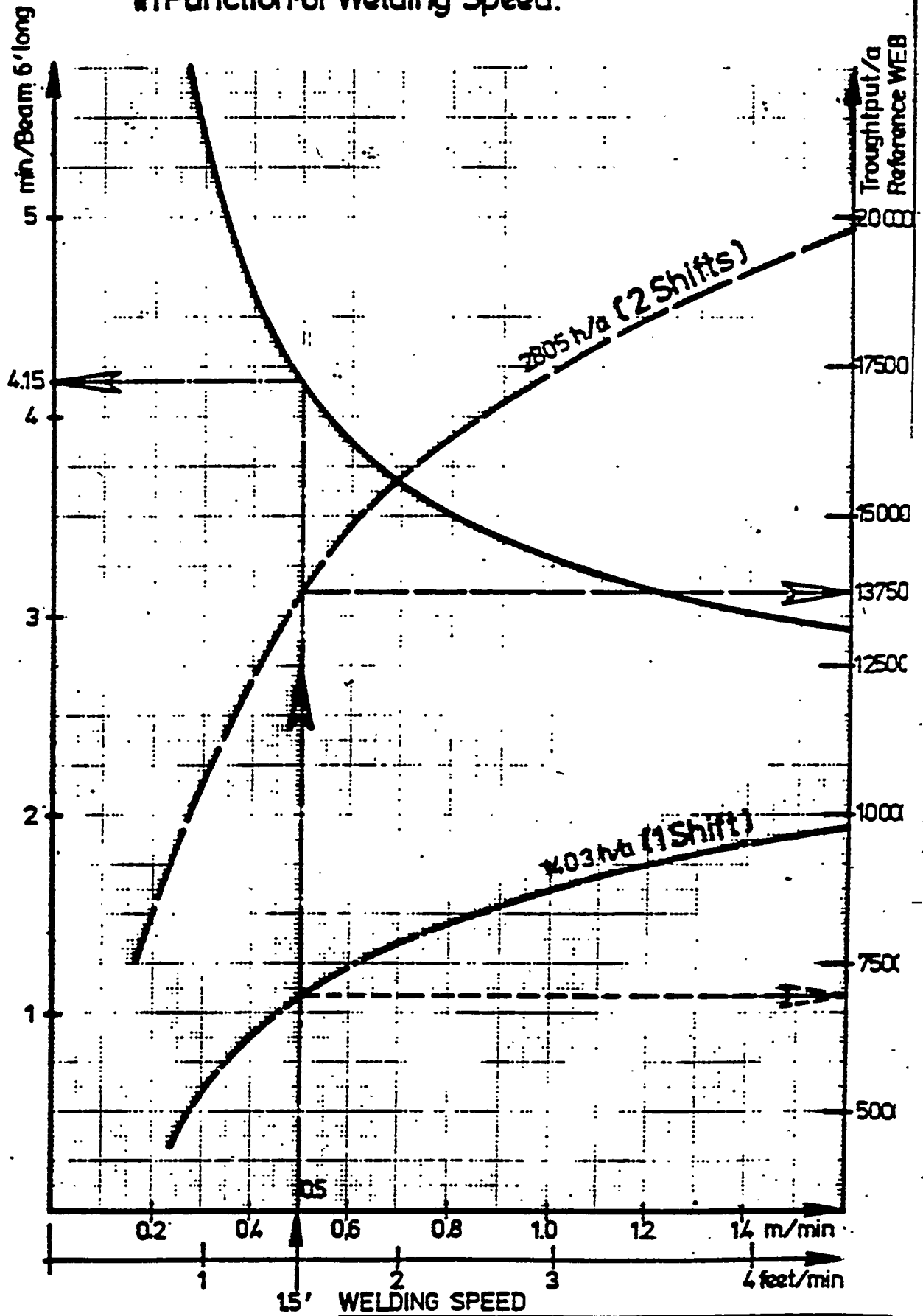
ACCORDING TO THE SURFACE CONDITION OF THE WORK PIECE AND THE PRIMER APPLIED, THIS COULD VARY BETWEEN 12 IN. AND 32 IN. PER MINUTE. THE INFLUENCE OF THE SHOP PRIMER IS DEALT WITH IN DETAIL IN THE APPENDIX AND ALSO IN THE PRECEDING PARAGRAPH # 2. 30. THE WELDING AREA OF THE BEAM MUST BE CLEANED AND A PRIMER HAS TO BE UTILIZED WHICH CREATES A MINIMUM OF POROSITY." IF THIS IS NOT DONE, WELDING SPEED MUST BE REDUCED. THE EVALUATION OF THIS PROJECT REGARDING-THROUGHPUT IS SUMMARIZED IN FIGURE 9. THE DESIGN PERMITS CALCULATIONS OF THE CYCLE TIME FOR A 6 FT. LONG BEAM AND THE ANNUAL THROUGHPUT OF REFERENCE WEBS, BOTH DEPENDING ON WELDING SPEED. THE EXAMPLE IN FIGURE 9 IS BASED ON A WELDING SPEED OF 1.5 FT. PER MINUTE . THE THROUGHPUT WILL NOT BE LIMITED BY OTHER STATIONS BECAUSE THEIR CAPACITY CAN BE EASILY ADAPTED TO THE ABOVE STATION.

2.32 WORK FLOW, TRANSPORT LANES AND TIMES

PROPOSALS A TO E REPRESENT A CONSIDERABLE IMPROVEMENT IN REGARD TO MATERIAL FLOW WHEN COMPARED TO PRESENT EXPERIENCE. TRANSPORT LANES AND TIMES ARE ALSO REDUCED WITH LIKE JOBS BEING HANDLED AT THE SAME WORK STATION CONSISTENTLY. THE WELL-ORGANIZED MATERIAL FLOW ENABLES THE USE OF A MANAGEMENT SYSTEM WHICH INSURES THE ABILITY TO RECOGNIZE AND AVOID BOTTLENECKS AT AN EARLY STAGE.

Production Time for Beams 6' long and
annual Throughput for Reference Webs
in Function of Welding Speed.

FIGURE 9



Ergebnisse der Untersuchung
nach DVS-Merkblatt 0501

Results of Tests according
to DVS-Standard 0501

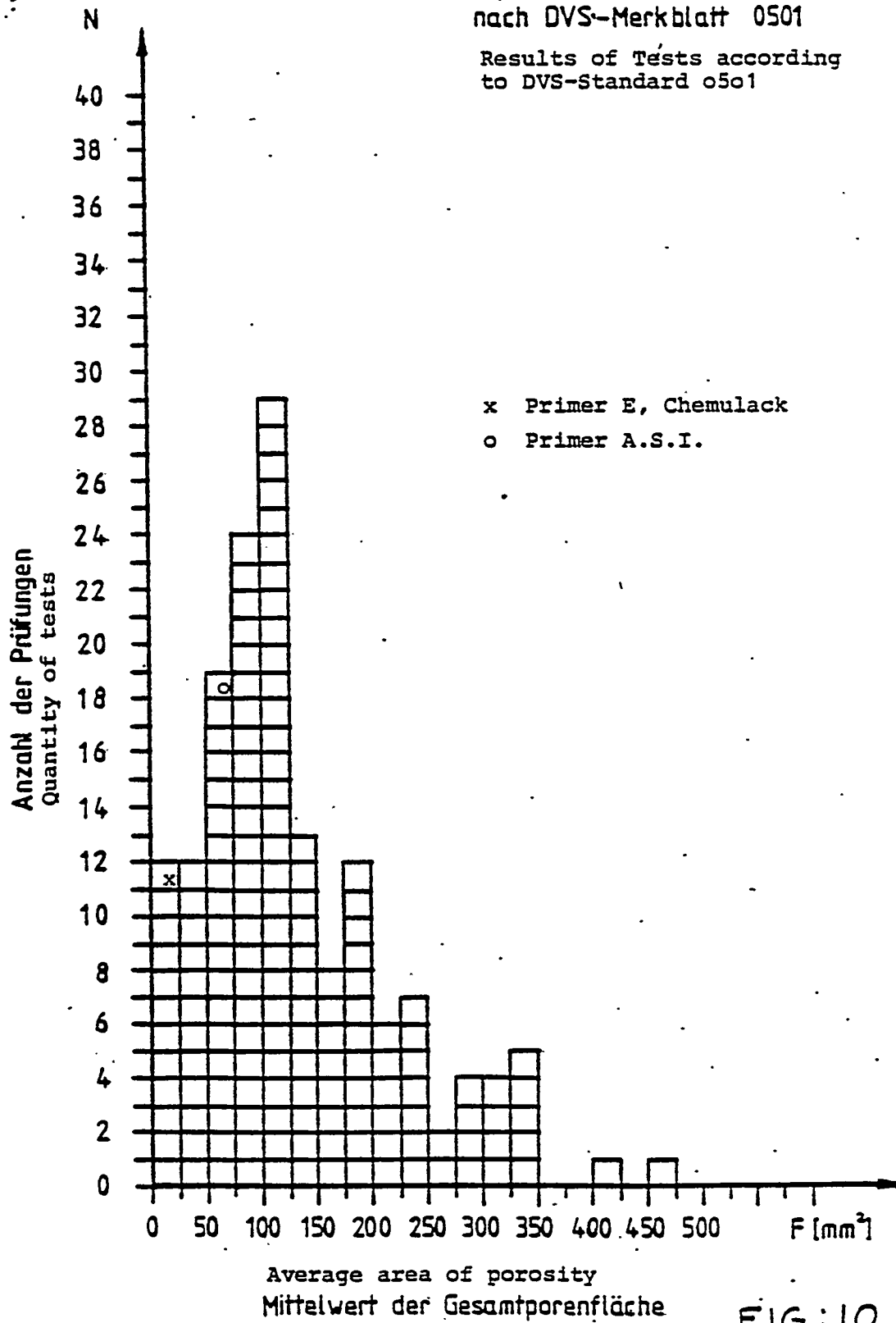


FIG:10

2.33 DETERMINATION OF STATE OF THE METHOD BY INTERVIEWS WITH
KNOWLEDGEABLE INDIVIDUALS IN OTHER SHIPYARDS AND
INDUSTRIES BOTH FOREIGN AND DOMESTIC

PANEL PRODUCTION LINES

WORLD WIDE THERE ARE MANY PANEL LINES IN OPERATION. USUALLY BEAMS ARE POSITIONED ONTO RECTANGULAR PLATES, PARALLEL, AND EQUIDISTANT TO EACH OTHER AND ARE THEN WELDED. ONE OF THE LARGEST PANEL LINES WAS INSTALLED FOR THE INGALLS SHIPYARD IN PASCAGOULA, MISSISSIPPI, AND ONE OF THE SMALLEST FOR BREMER VULKAN IN WEST GERMANY. THE EXPERIENCES ENCOUNTERED DURING THE POSITIONING AND WELDING OF BEAMS ON A PANEL LINE HAVE LIMITED RELEVANCE TO A WEB LINE.

STATIONARY POSITIONING MACHINE

THIS STATION IS EQUIPPED WITH A CONVEYER SYSTEM FOR PANEL PLATES AND A CLAMPING PORTAL WHICH IS RESPONSIBLE FOR THE FEEDING IN OF THE BEAMS, CLAMPING AND WELDING. THE PANEL PLATES ARE LAID OUT ON THE CONVEYER IN FRONT OF THE POSITIONING MACHINE AND ORIENTED ALONG THE LENGTH SIDE. NEXT THEY ARE SENT TO THE POSITIONING MACHINE VIA A DISPLACEMENT DEVICE. BEAMS ARE TRANSPORTED HORIZONTALLY VIA A GUIDE SYSTEM IN A FEED TROLLEY, AND THEY ARE FINALLY POSITIONED ABOVE THE CORRESPONDING PANEL. THEY ARE THEN LOWERED AND CLAMPED BY HYDRAULIC CYLINDERS. THE GUIDE SYSTEM LEAVES AFTER CLAMPING, SO AS TO MAKE ROOM FOR THE WELDING EQUIPMENT. DOUBLE FILLET WELDING IS PERFORMED USING ONE OR TWO TROLLEYS. FOR PANELS WHICH ARE WIDER THAN 25 FT. TWO WELDING TROLLEYS ARE GENERALLY USED. IN ORDER TO REDUCE DISTORTION, WELDING

IS CARRIED OUT FROM THE MIDDLE TO THE OUTER EDGE. BEAMS CAN ONLY BE POSITIONED VERTICALLY. BEAMS VARY IN SIZE FROM 4 IN. TO 4 FT. 7 IN. HIGH AND HAVE FLANGES UP TO 16 IN. WIDE. THE USUAL METHOD OF WELDING IS DOUBLE FILLET, SUBMERGED-ARC WELDING IN TANDEM OPERATION. DIAMETER OF WELDING WIRE IS APPROXIMATELY 5/32 IN. WELDING CURRENT IS 780 AMPS. AT 28 TO 32 VOLTS. PANEL PLATES AND BEAM EDGES IN THE WELDING ARE METALLIC CLEANED. WELDING SPEEDS OF 4 FT. PER MINUTE ARE ATTAINED.

TRAVELING BEAM POSITIONING MACHINE

AS BEFORE, THE PANEL PLATES LIE ON A CONVEYER. THE POSITIONING MACHINE ITSELF CAN BE DRIVEN AND CAN REMOVE THE BEAMS FROM A PALLET. THE BEAMS ARE TRANSPORTED, POSITIONED, CLAMPED AND WELDED. THE TAKE-UP DEVICE FOR THE BEAMS CAN BE ROTATED. THUS, THE ANGLE OF THE BEAM TO THE PANEL EDGE CAN BE SET AS DESIRED.

AT PRESENT THERE ARE TWO SUCH PLANTS IN OPERATION. ONE AT THE AUSTIN PICKERSGILL IN ENGLAND, AND FSG IN FLENSBURG, WEST GERMANY. THE PLANT INSTALLED AT AUSTIN PICKERSGILL ONLY POSITIONS AND CLAMPS THE BEAMS; TACKING IS CARRIED OUT MANUALLY, AND FOR SUBSEQUENT WELDING A DOUBLE FILLET WELD DEVICE IS APPLIED AT ANOTHER STATION. AT FSG IN FLENSBURG, ONE BEAM AT A TIME IS PICKED UP FROM A PALLET BY A TRAVELING AND POSITIONING PORTAL. PRESSING DOWN ON THE BEAM IS PERFORMED BY A HYDRAULIC CLAMP. BUCKLING OF THE PLATES IS DRAWN OUT USING HAND ADJUSTABLE MAGNETS. TACKING IS ALSO MANUAL.

AUTOMATIC WELDING IS CARRIED OUT WITH A SECOND TRAVELING STATION. AGAIN, TWO TWIN WELDING UNITS WELD FROM THE MIDDLE TO THE OUTSIDE. THE WELDING TECHNOLOGY APPLIED IS DESCRIBED UNDER POS. 12.

PRODUCTION LINE FOR SMALL SECTIONS

TWO PRODUCTION LINES FOR THE PRODUCTION OF SMALLER SHIP SECTIONS (WEBS AND BRACKETS) ARE KNOWN. ONE IS AT HARLAND & WOLFF IN BELFAST, U.K., THE OTHER AT BREMERBULKAN, BREMEN, GERMANY. BOTH PLANTS ARE EQUIPPED WITH TRANSPORT TABLES, ONTO WHICH SMALL CUT PLATES CAN BE LAID IRREGULARLY. BEAMS ARE CONVEYED BY HAND OR WITH HAND OPERATED MANIPULATORS WHICH ARE USED TO PICK UP THE BEAMS FROM A PALLET. THEY ARE THEN POSITIONED VISUALLY AND PRESSED ON WITH THE MANIPULATOR. TACKING AND WELDING IS PARTIALLY PERFORMED MANUALLY AND PARTIALLY USING THE GRAVITY WELDING METHOD. AS ELECTRODES ARE APPLIED FOR WELDING, THE TYPE OF THICKNESS OF PRIMER HAS LITTLE INFLUENCE.

BEAM POSITIONING AND WELDING MACHINE

ACCORDING TO PRESENT KNOWLEDGE, A BEAM POSITIONING AND WELDING MACHINE FOR AUTOMATIC PICKING UP, POSITIONING IN ANY DIRECTION, PRESSING DOWN AND WELDING WITHOUT TACKING DOES NOT EXIST ANYWHERE IN THE WORLD.

SECTION THREE

COMPUTER SOFTWARE FOR THE SEMI-AUTOMATIC WEB LINE

3.1 INTRODUCTORY NOTE

THIS SECTION PRESENTS SOME REQUIREMENTS FOR THE COMPUTER SOFTWARE THAT MUST BE DEVELOPED AND MADE AVAILABLE TO SUPPORT THE SEMI-AUTOMATIC WEB LINE. THE SYSTEM THAT IS ENVISIONED WILL PROCESS THE REQUIRED DATA AND, THROUGH AN INTERFACE, DRIVE THE SHOP MACHINES (CNC-DNC), OPTIMIZING PLATE CUTTING EFFICIENCY TO MINIMIZE SCRAP AND MAXIMIZE SHOP LOAD.

3.2 COMPUTER-AIDED DRAWING SYSTEM (CAD)

THE COMPUTER-AIDED DRAWING SYSTEM WILL DAILY CREATE DETAILED DRAWINGS. THESE DRAWINGS WILL BE MADE WITH THE AID OF THE COMPUTER GRAPHIC DISPLAY SYSTEM THAT WILL BE MODIFIED TO MEET A PARTICULAR YARD'S NEEDS. THE GRAPHIC SYSTEM WILL UTILIZE A MASTER FILE AS STANDARDS DETAILS THAT WILL BE PASSED TO THE WEB LINE MANAGEMENT SYSTEM, WHICH IN TURN WILL FEED BACK INFORMATION TO CAD FOR THE ACTUAL ROUTING AND PRINTING OF THE DETAILED DRAWINGS. THE PRIMARY OBJECTIVE OF CAD IS TO OFFSET ANY MAJOR INCREASE IN THE ENGINEERING STAFF TO PROVIDE THE DRAWINGS AND OTHER DATA IN A TIMELY MANNER.

3.3 WEB LINE MEASUREMENT SYSTEM (WLMS)

THE PURPOSE OF THE WLMS IS TO AID IN THE SCHEDULING AND OPERATIONS OF THE SHOP. TO ACCOMPLISH THOSE PURPOSES, TWO MAJOR INPUTS MUST BE PROVIDED. THE FIRST OF THESE IS A FILE OF DETAILED DRAWINGS THAT WILL BE PRODUCED BY CAD. THE SECOND MAJOR INPUT IS THE MASTER SCHEDULE (WEB PROCESSORS). THE WLMS WILL USE THESE TWO MAJOR SYSTEMS OF INPUT, AND OTHER PRELOADED SYSTEM MASTER FILES, TO SCHEDULE WORK THROUGH THE SHOP. THE OTHER SYSTEM MASTER FILES WILL CONTAIN DATA ON EACH OF THE MACHINES IN THE SHOP: E.G., LOAD CAPACITY; MAXIMUM SIZE; AND OTHER SPECIAL INFORMATION REGARDING EACH ITEM. THIS SET OF FILES WILL ALSO CONTAIN A CATALOGUE OF EACH STANDARD THAT IS USED BY THE SHOP. THE WLMS WILL ALSO PRODUCE INFORMATION ON DAILY MATERIAL REQUIREMENTS, ASSEMBLY MARKING INFORMATION, FINAL DISPOSITION OF COMPLETED WORK, AND A SHOP STATUS REPORT. ONE OBJECTIVE OF WLMS IS TO ALLOW FOR THE CONCURRENT PREPARATION OF: SHOP PRODUCTIONS SCHEDULES, MATERIAL SCHEDULE REQUIREMENTS, WORK STATION LOADINGS, AND MORE. ANOTHER OBJECTIVE OF THE WLMS IS TO CONTROL THE STORAGE RETRIEVAL, AND SIGHT DELIVERY OF PALLETIZED COMPLETED WORK PIECES WHICH HAVE BEEN PRODUCED IN THE SHOP.

3.4 COMPUTER NUMERICAL CONTROL (CNC)

THE MACHINE CONTROL COULD BE MICROPROCESSOR-SPACED, PROGRAMMABLE COMPUTER NUMERICAL CONTROL (CNC), WITH DIRECT NUMERICAL CONTROL (DNC) CAPABILITY THROUGH TWO INTERFACES. ALTHOUGH CAPABLE OF LOCAL DIRECTION, THE NORMAL MODE WOULD BE THROUGH A DIRECT LINK TO THE APPROPRIATE COMPUTER CENTER.

SECTION FOUR
ADVANCED RESEARCH AND DEVELOPMENT

4.1 INTRODUCTORY NOTE

DURING THE COURSE OF THIS STUDY, AREAS WHICH OFFER GOOD POTENTIAL FOR SIGNIFICANT PRODUCTIVITY GAINS WERE OBSERVED, AND WERE RECOMMENDED FOR THIS SECTION, WITH THESE SUGGESTED SELECTED TOPICS AS MERITING ADDITIONAL INVESTIGATION.

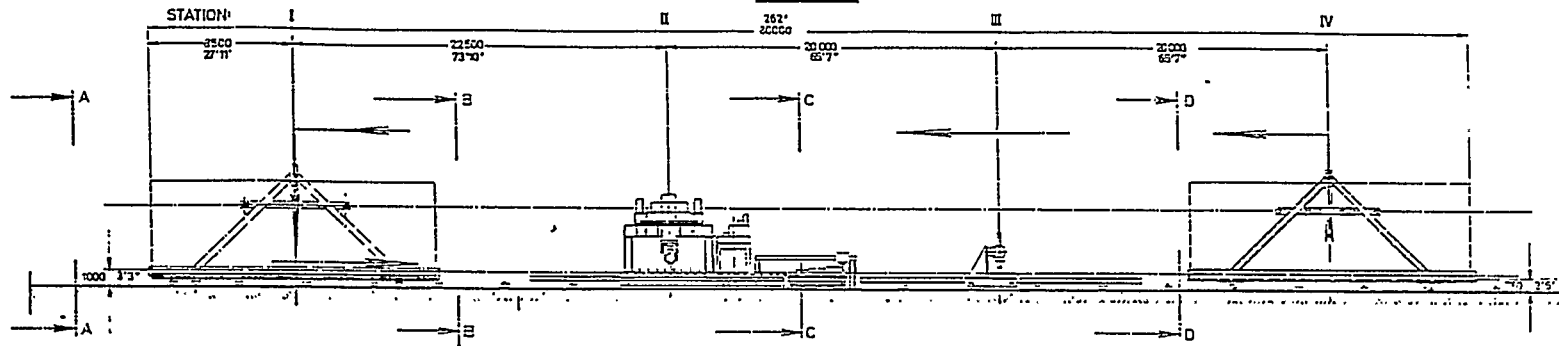
4.2 MACHINE-COMPUTER INTERFACE

PRESENTLY, SUBSTANTIAL EMPHASIS IS BEING DIRECTED TOWARDS CAD/CAM IN OUR INDUSTRY. FROM A FACILITIES POINT OF VIEW, COMPUTER-DRIVEN MACHINERY OR COMPUTER-DRIVEN SYSTEMS REQUIRE RESEARCH IN INTERFACE. THERE ARE MEDIUMS AVAILABLE THAT PROVIDE COMPUTER-MACHINE COMMUNICATION. ADDITIONAL RESEARCH IS DESIRABLE IN THE MATTER OF COMPATIBILITY REQUIREMENTS OF THE MACHINE CONTROLS, SYSTEMS, INTERFACE, AND MAIN FRAME COMPUTER.

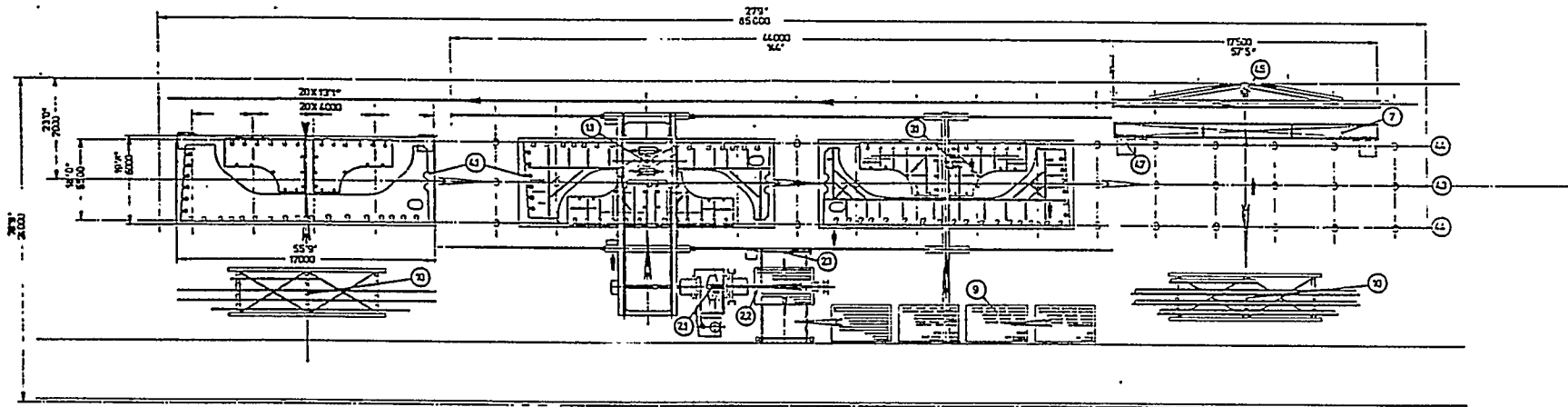
SECTION FIVE
ALTERNATE PLANS AND DRAWINGS

IN THE COURSE OF THE STUDY, FIVE PLANS WERE DEVELOPED, ALL OF WHICH MEET THE DESIGN CRITERIA AS TO THROUGHPUT, AND PLAN A WAS SELECTED AS THE ONE HAVING MOST MERIT. PLAN B IS THE MOST SIMILAR TO PLAN A IN THAT IT PROVIDES FOR CUTTING OF WEB PLATES ON THE WEB PRODUCTION LINE, AS OPPOSED TO THIS OPERATION BEING PERFORMED ELSEWHERE IN THE SHIPYARD. PLAN B DOES NOT, HOWEVER, HAVE PROVISIONS FOR INSTALLATION OF FACE PLATES ON THE WEB FRAMES, OR FOR THE INSTALLATION OF BEAMS AND STIFFENERS ON THE BACKSIDE OF THE WEBS. ON PLANS C, D, AND E PREVIOUSLY CUT WEB PLATES ARE DELIVERED TO THE SAWL, INDIVIDUALLY ORIENTED, MARKED, AND FINISHED IN MANNERS SIMILAR TO THE SEMI-AUTOMATIC OPERATIONS OF PLAN A AND B. ON ALL PLANS, EXCEPT PLAN E, THE WORK PIECES TRAVEL DOWN THE PRODUCTION LINE(S) TO THE WORK STATIONS. ON PLAN E WORK PIECES ARE PLACED AT MANY LOCATIONS ALONG THE PRODUCTION LINE AND THE WORK STATIONS TRAVEL TO THE WORK PIECES. THERE FOLLOW DRAWINGS OF VARIOUS TYPICAL WEB SECTIONS, AND FOUR LAYOUT DRAWINGS, ONE EACH FOR THE ALTERNATE PLANS B, C, D, AND E.

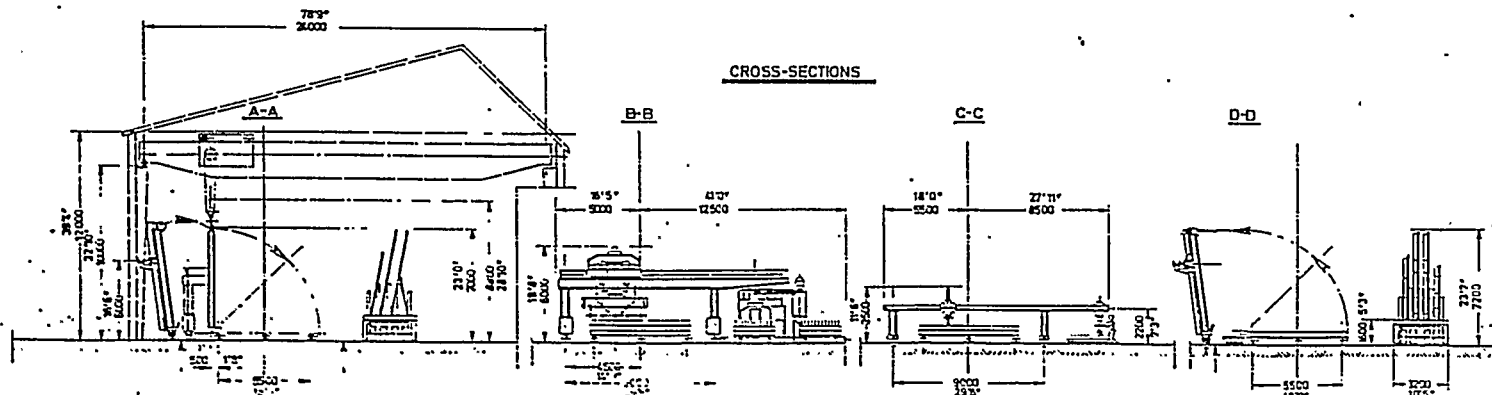
SIDE-VIEW



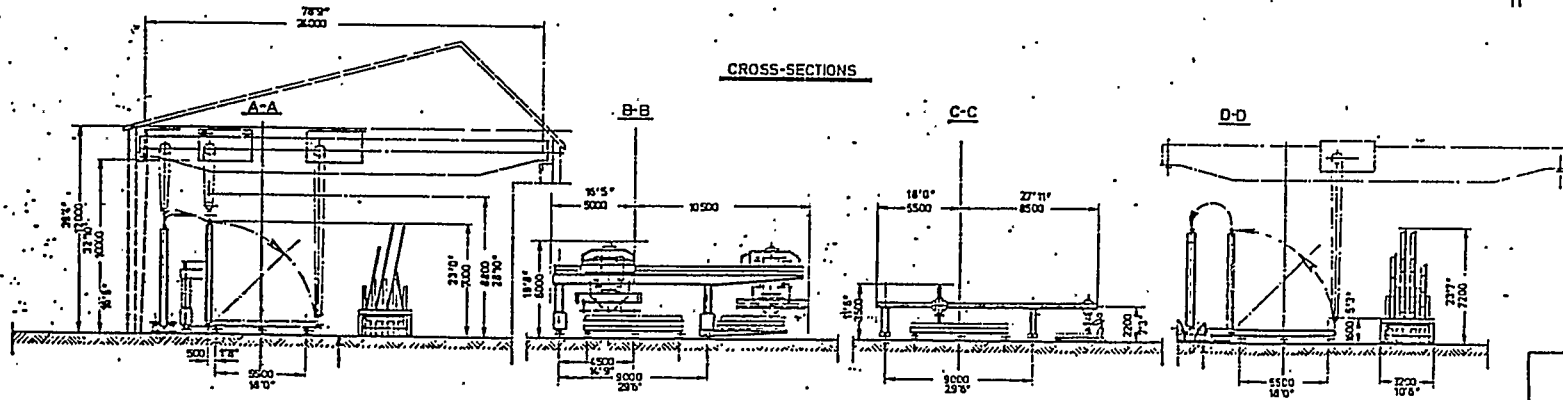
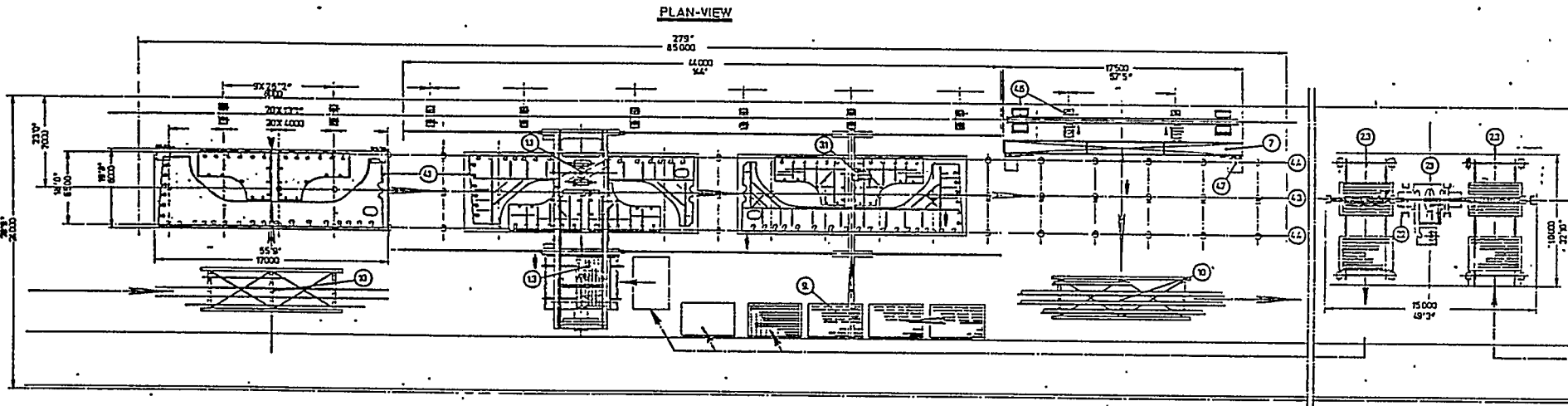
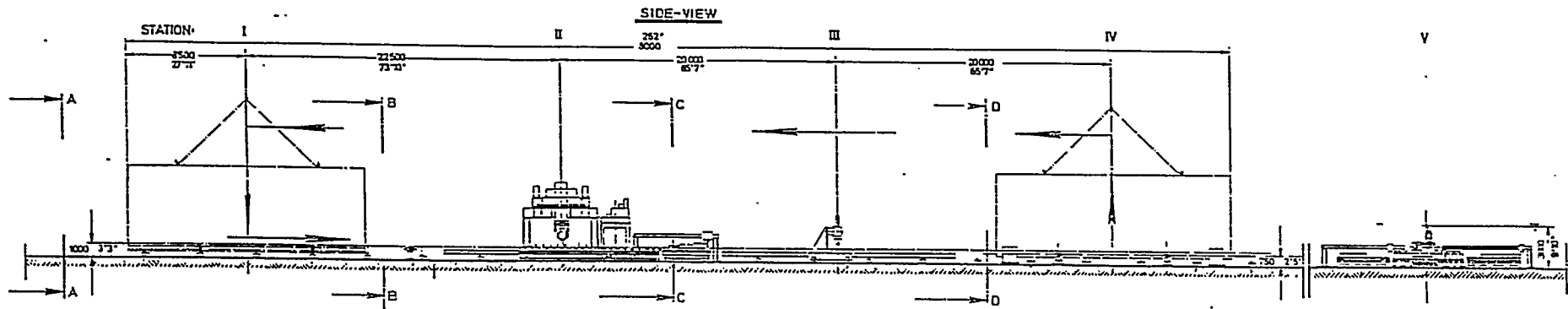
PLAN-VIEW



CROSS-SECTIONS



LAYOUT
PLAN "C"



**LAYOUT
PLAN "D"**

PRODUCTION FLOW AND RATE Proposal: "B"

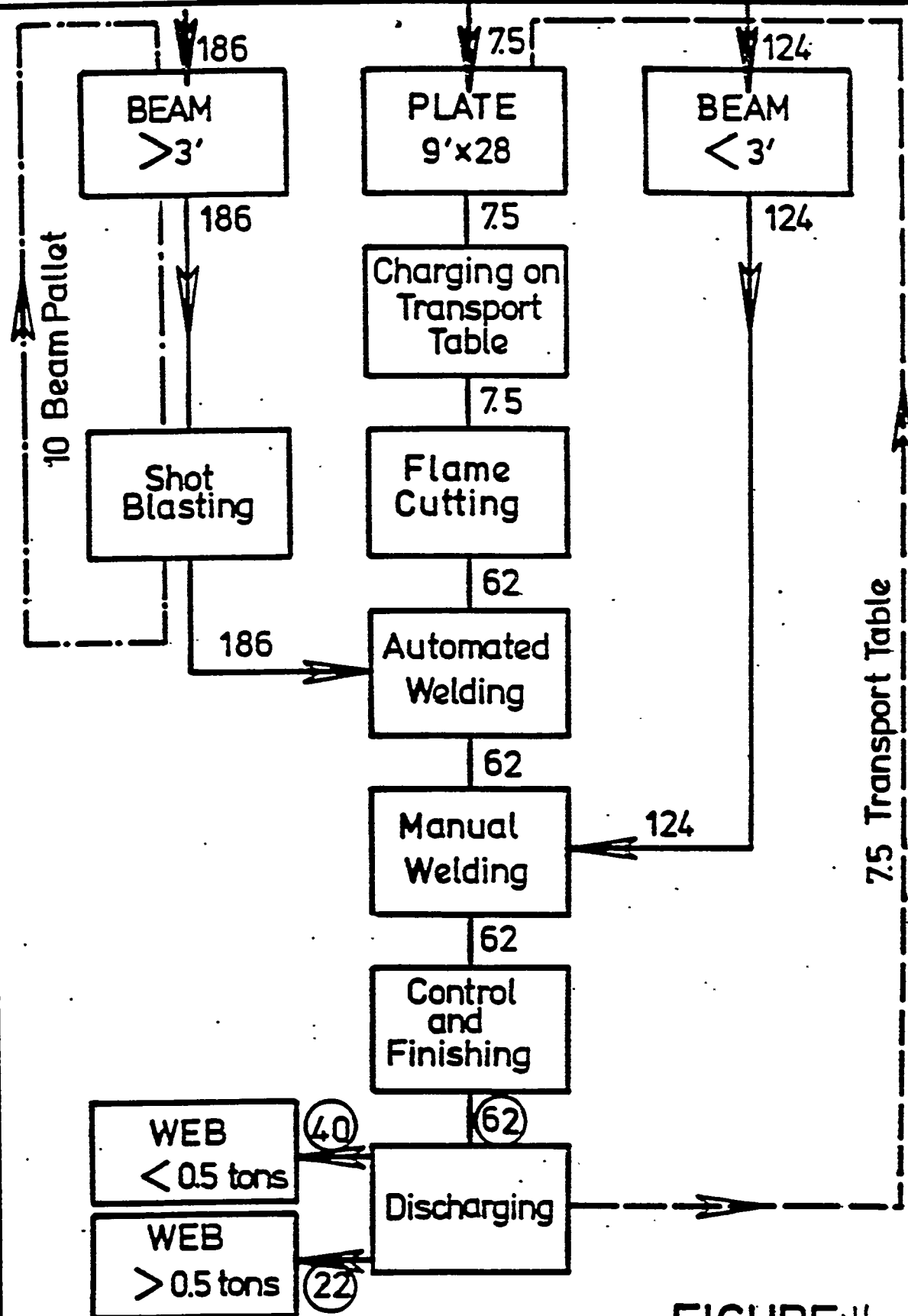


FIGURE:11

PRODUCTION FLOW and RATE. Proposal: "C" & "D"

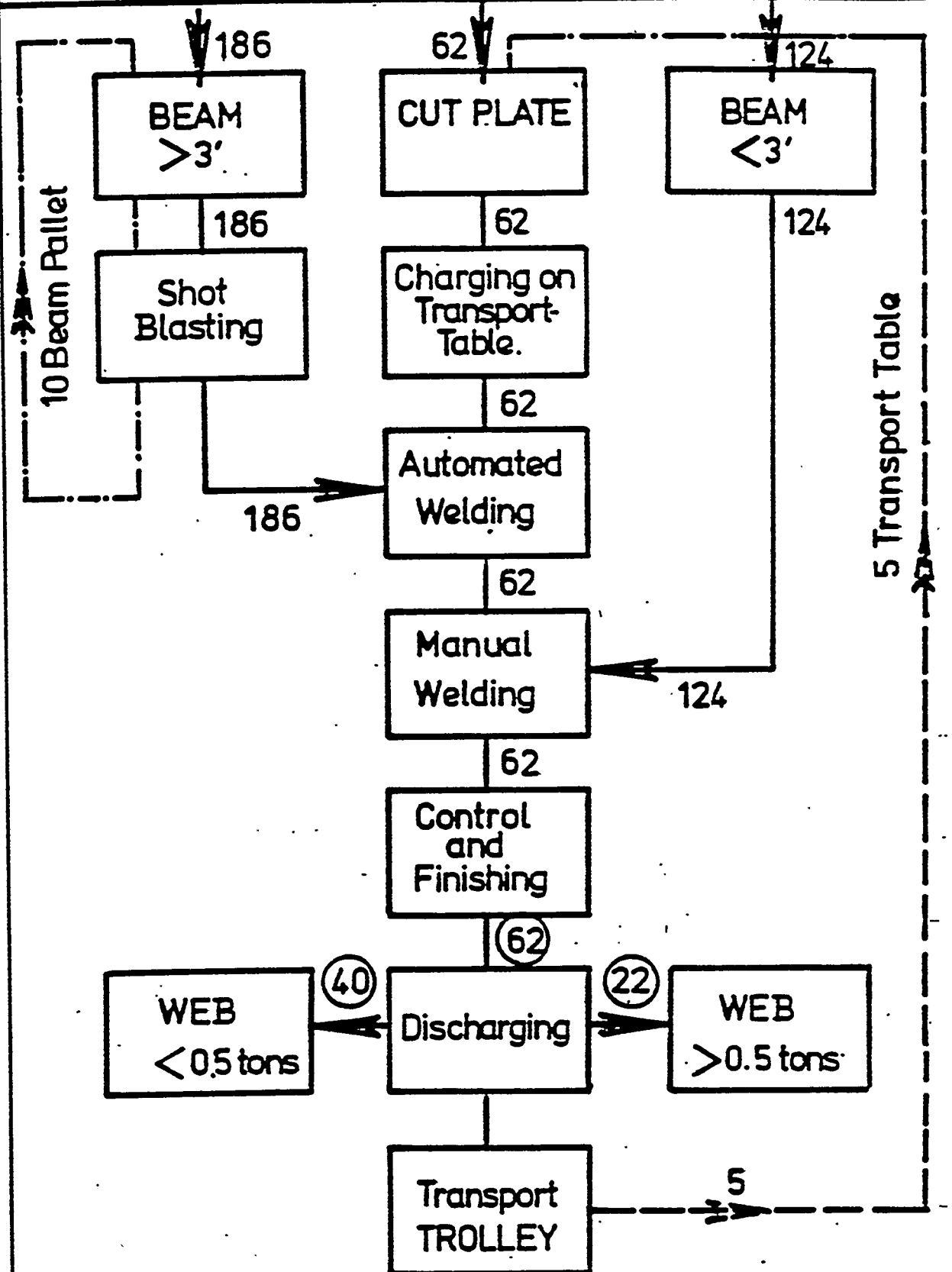


FIGURE:12

PRODUCTION FLOW and RATE. Proposal : E

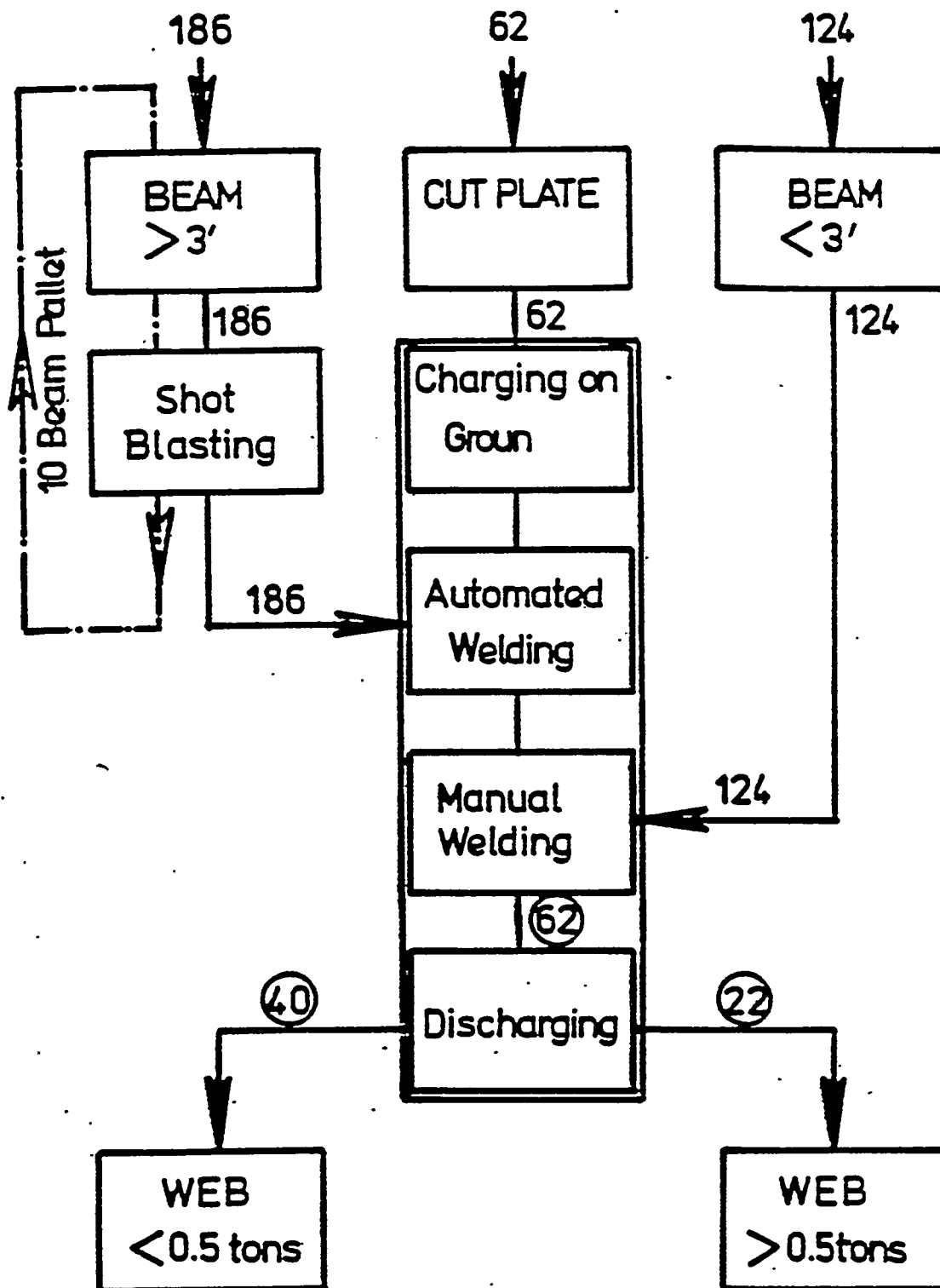


FIGURE:13

SECTION SIX

APPENDIX

REPORTS AND STANDARDS

TEST REPORT No. 8434013

TEST REPORT No. 8439025

DAST CODE OF PRACTICE 006

DIRECTIVE DVS 0501 (MARCH 1976)

TEST REPORT No. 7935104

APPROVAL LLOYD'S REGISTER OF SHIPPING

APPROVAL GERMANISCHER LLOYD

APPROVAL AMERICAN BUREAU OF SHIPPING

APPROVAL DET NORSKE VERITAS

TECHNISCHES MERKBLATT CHEMULACK

TYPICAL WEB AND BEAM DRAWINGS



SCHWEISSTECHNISCHE LEHR- UND VERSUCHSANSTALT DUISBURG

DES DEUTSCHEN VERBANDES FÜR SCHWEISSTECHNIK e. V.
41 DUISBURG 1 · POSTFACH 10 02 01 · BISMARCKSTRASSE 85 · FERNSPRECHER (0203) 35 30 55



— Staatlich anerkannt als Ausbildungs- und Prüfungsstelle für Schweißtechnik —

Test report No. 84 34 013

Client: Oxytechnik
Frankfurter Str. 10 - 14
6236 Eschborn 1

Reference: Testing the tendency to porosity
in accordance with DVS-Rule 0501,
edition March 1976

Designation of the shopprimer: Weblin/Primer Interplate 8
(NQA 200)

Characteristic pigment-base: Zinkstaub

Characteristic vehicle-base: Ethylsilikat

1. Chemical Composition of base metal and welding wire

		%				
		C	Si	Mn	P	S
Welding wire		0,098	0,81	1,47	0,014	0,010
Base metal	12 x 50	0,09	0,24	0,42	0,017	0,019
	20 x 80	0,08	0,23	0,37	0,014	0,020

Welding wire: SG 2, DIN 8559

Base metal: C 10, DIN 1652

Empfänger **Oxytechnik, Eschborn**

Datum **22.05.88**

Blatt
2

2. Dry-film thickness

Measure- ment No	First sheet	Last sheet
1	22	19
2	21	22
3	23	23
4	23	20
5	22	22
6	23	23
7	21	22
8	20	23
9	21	22
10	23	22
Average value	21,9	21,8
Total average value	21,85	

Measuring instrument: Permascope (magnetic-inductiv)

3. Result of testing

Specimen- No.	Number of pores n	Total area of pores F (mm ²)	mean area of a single pore F/n (mm ²)
1	41	70,72	1,72
2	31	59,50	1,91
3	23	30,28	1,31
4	26	83,66	3,21
5	38	59,59	1,56
6	28	96,72	3,45
7	37	82,05	2,21
8	37	86,84	2,34
Average value	32	71	2,2
C. L. ¹⁾	16,7	24,7	28,9

¹⁾ C. L. = Control Limit of the average value on the 95 % - level related to the average value (%).

At the present state of knowledges the total area of pores "F" is the best predicating value.

The mean total-area of pores is: 71,0 mm²

The testing laboratory keeps a column diagramm in which continuing all test results (mean value of total-area of the pores) are registered. The diagramm is obtainable at the testing laboratory.

Schweißtechnische Lehr- und Versuchsanstalt Duisburg

des Deutschen Verbandes für Schweißtechnik e.V.

— Staatlich anerkannt als Ausbildungs- und Prüfstelle für Schweißtechnik —

Empfänger **Oxytechnik, Eschborn**

Datum **22.05.84**

Blatt

4

4. Declaration

The above testing were carried out in accordance with the DVS-rule 0501, edition 1976. The determinations of this rule were observed.

The application of this rule gives a impractical, intensiv porosity. Because of differentiability and reproducebility the intense porosity is necessary for testing.

Duisburg, 22. Mai 1984
Heu./Gh./Kit.



SLV Duisburg
(Welding Research Center)

Investigation report no.

84.39 o25

Ordered by:

OXYTECHNIK Gesellschaft für
Systemtechnik mbH
Frankfurter Straße 10-14
6236 Eschborn

Compiled by:

Herr Dipl.-Ing. Lehmler

An investigation of pore tendency during welding over an American shop primer using different inert gas wires.

Procedure

Tests were carried out for the client to determine tendency to pore formation during welding over the American shop primer "Weblime/Primer".

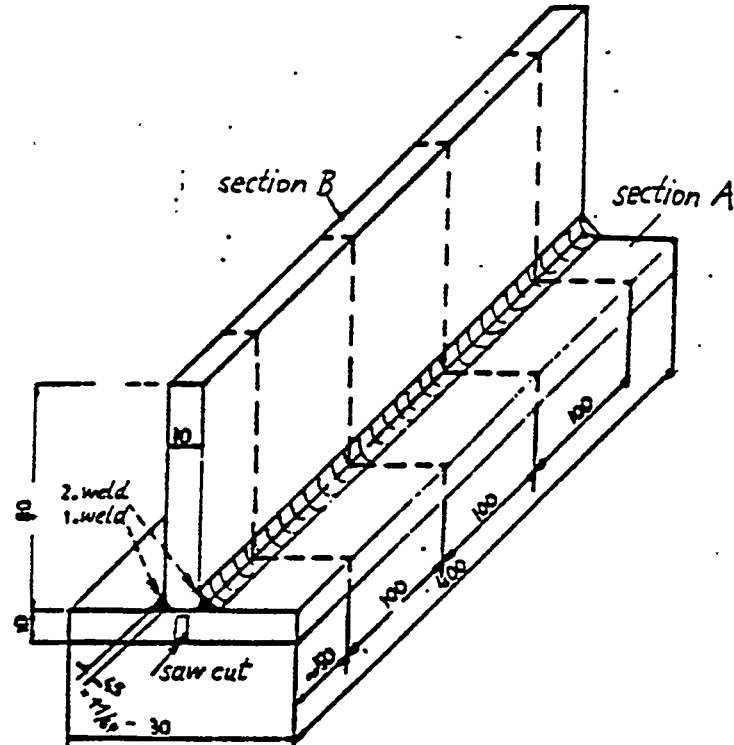
The aim was to ascertain the maximum possible speed at which fillet welding can be performed without the formation of an unacceptable level of porosity.

In accordance to German standard procedure, /1, 2/ only shop primers which have been tested in compliance with the DVS standards /3/ for pore formation during welding, and where the total pore area produced does not exceed 125 mm^2 , may be used in steel and ship building, subject to acceptance.

The investigation of the "Weblime Primer" in accordance with these standards produced an average total pore area of 71 mm^2 for an average coating thickness of 21 thereby proving it to be a suitable primer.

Report no. 84 34 o13 of the SLV in Duisburg.

Following this, tests were carried out under realistic conditions, to find the maximum possible welding speed. The tests were carried out in accordance with DAST standards 006/1 and 2/, i.e., double fillet welds were performed in the tests - as in the sketch below.



In each case an a-measurement of 4.5 mm = 11/64" was maintained. The test sections were made from hot-rolled wide flat plate St 37-2 to DIN 59200.

The upper surface of the sections to be joined had been treated in varying ways.

1. Section A and section B shot-blasted.
2. Section A shot-blasted/ Section B shot-blasted and completely coated.
3. Section A shot-blasted and coated/Section B shot-blasted.

After coating, the treated areas took 10 days to dry. The coating layer measured 25 μ on section A (\pm 5 μ).

Section B was coated with a layer of 40 - 50 μ , in order to simulate the thicker layers on plate edges that occur under normal working conditions.

The company OXYTECHNIK provided four inert gas wires for the tests.

Wire A: Solid wire; ϕ 1.0 mm, type: 85 Company: Alloy Reds Div.

Wire B: CO₂ cored wire; ϕ 1.2 mm; type: Nittetsu SF-1
Company: Nippon Steel Welding Products.

Wire C: CO₂ cored wire; ϕ 1,6 mm; type: TM 711
Company: Tri Mark.

Wire SG2: German standard wire

Welding was carried out by machine in horizontal welding position. Power supply was available in the form of an AEG rectifier (LEG 500 K).

Welding was performed with a torch directed against the finished part of the joint (tilting angle: 12°).

Since the inert gas method exerts little influence on pore formation for welding over of production coats /4/, all welding was carried out using CO₂.

On completion of the double fillet welds, sections A were sawn up (see sketch) and finally the test sections were broken. Pores caused by the coats (mechanic pore formation) always lie in the median of the seam, because of the solidification effect.

In each case, it was possible by exerting force, to bring about a fracture along this surface. The fractured areas were then enlarged to 10 x their normal size and projected onto a screen, so that the pore area could be measured.

Results

The findings are listed in the following table, and some results are documented with pictures. Each fractured area shows a representative section from a 400 mm = 16" long seam.

The aim of the investigation was to meet the requirements of the DAST standard 006/1/, i.e. the average total pore area produced in these work simulations should not exceed 4 % for dynamic or 7 % for static load.

It proved impossible to fulfill these requirements for primed section B (45 °). For all four inert gas wires the average pore area was more than 10 % with welding speeds of around 30 cm/min = 12"/min.

The maximum welding speed at which pore area was lower than 4 % emerged for the solid wire A (\varnothing 1,0 mm), welding coated sections A and uncoated sections B at a speed of 30 cm/min = 12"/min.

Figs. 1 and 2 show the penetration and view of fraction on test No. 31 from these series. The fact that emerges from welding uncoated plates is that an a-measurement of 4.5 mm = 11/54" with the 1.0 mm solid wire cannot be achieved at speeds greater than 40 cm/min = 16"/min.

The maximum possible welding speed with 1.2 mm solid wire for welding of coated sections A and uncoated sections B was approx. 32 cm/min = 13"/min. It was possible to perform welding at a speed of 50 cm/min = 20"/min on uncoated plates with an a-measurement of 4.5 mm = 11/64".

Figs. 3 and 4 show the penetration and view of fraction of test No. 30 where there was an average pore area of 2.6 %.

With CO₂ an unusually large amount of spatters was evident, both during welding using 1 mm thick and 1.2 mm thick solid wire. This makes it almost impossible to weld seams longer than 500 mm = 20", because spatters in the nozzle prevent further gas flow.

Using the 2 cored wires, considerably less spattering occurred. As to pore formation, however, the 1.2 mm cored wire failed to produce a better weld than the 1.2 mm solid wire. This is because slag formation in the weld pool has an adverse effect on the degassing of the molten pool.

During welding speeds of 38 cm/min = 15"/min a pore area of 8% on average was produced. Plates without primer were welded at a speed of 50 cm/min = 20"/min for an a-measurement of 4.5 mm = 11/64". Figs. 5 and 6 are a reproduction penetration and view of fraction of test no. 30.

The 1.6 mm cored wire also achieved a speed of approx. 50 cm/min = 20"/min in tests on unprimed sections. Pore formation could only be reduced on primed section A by reducing the welding speed by approx. 30% to about 35 cm/min = 14"/min. Using the 1.6 mm cored wire an improved cristallisation is achieved during welding due to the lower penetration, and this in turn produces better conditions for degassing. However, slag formation still has an adverse effect on degassing. Porosity was less in test seams using cored wire for welding, but this is considered to be typical for fillet welds using cored wire.

Figs. 7 and 8 show penetration and view of fraction for test No. 26.

Conclusion

The investigation proved that fillet welds can be made on unprimed plates (10 mm) at a speed of about 50 cm/min = 20"/min for an a-measurement of 4.5 mm = 11/64".

For a primed section A with a coating thickness of 25 μ , the welding speed during welding using 4 different inert gas wires had to be reduced by about 30% to prevent an unacceptably high level of porosity, i.e. a pore area less than 4% in double fillet welds.

The most favourable results were achieved using cored wire welding, because an unusually large amount of spatters was caused when solid wire was applied.

This meant, for the necessary welding parameters, that it was impossible to weld seams longer than 50 cm = 20", without cleaning the gas nozzle at regular intervals. Spatters may, however, be reduced by applying mixed gases rich in Argon, instead of CO₂.

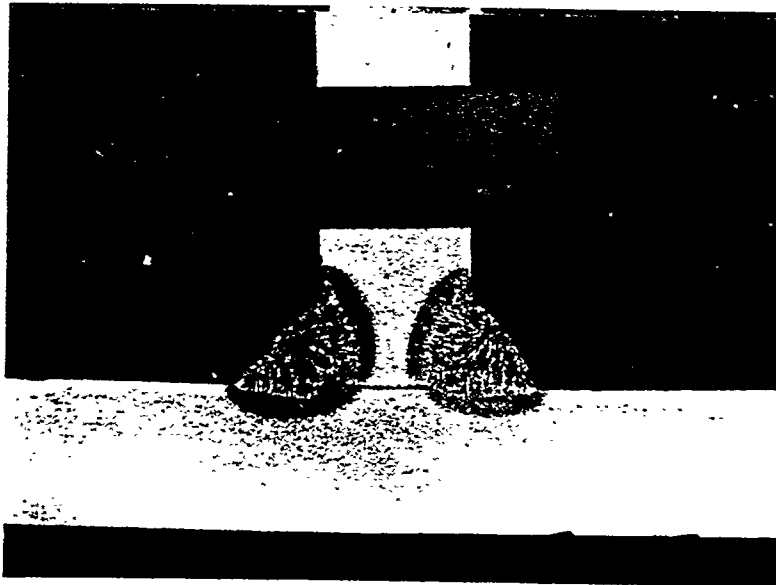
Should the coating be thicker than 25 μ , it is impossible to produce a near perfect pore-free seam.

Whilst the double fillet weld test sections were being prepared, the section B was placed on top of the section A (without pressure). However, since the pressure of the pieces to be joined exerts a great influence on porosity when shop primers are concerned, it is likely that greater porosity will result practically than emerged during our investigation.

This might occur during the welding of webs with the beam positioning and welding machine. In this event, there is increased area pressure of the beam upon the cut plate, in the area of the pressure piston.

45781

V = 2:1



45780

V = 1:1

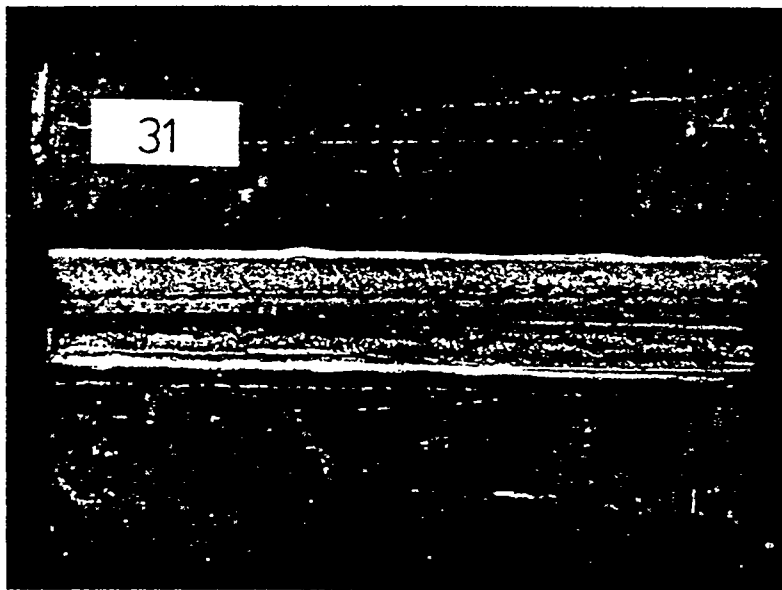
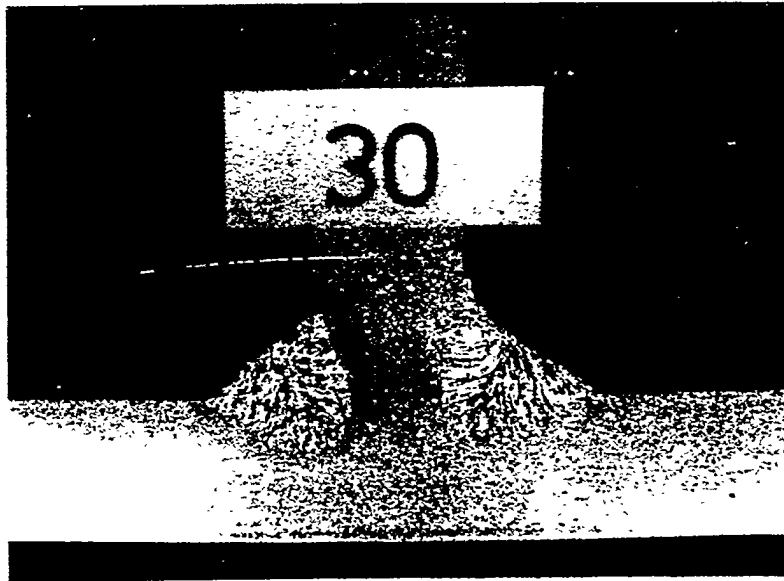


Bild 1 und 2: Einbrandform und Bruchbild zum Versuch 31;
 Draht - \emptyset = 1,0 mm (Massivdraht),
 I_s = 235 A, U_s = 27 V, s = 33 cm/min; a-Maß=5 mm
 Porenfläche = 4,4 %

Figs 1 and 2: Penetration and fraction area in test no. 31.
 Wire \emptyset 1.0 mm. (Solid wire).
 Pore area = 4,4%

4577 9

V = 2:1



4577 8

V = 1:1

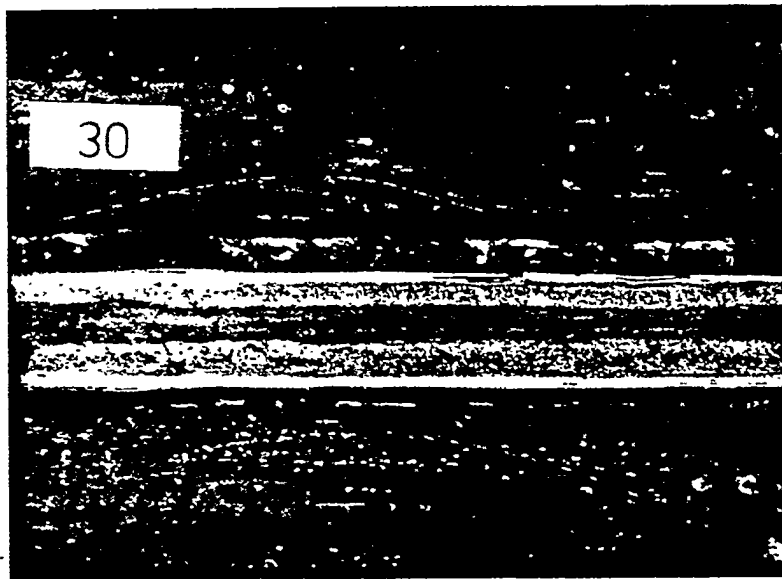


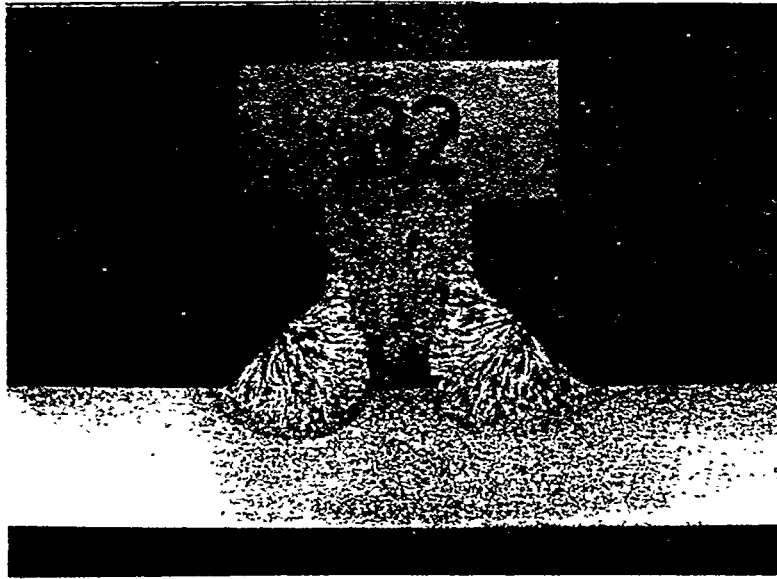
Bild 3 und 4: Einbrandform und Bruchbild zum Versuch 30
Draht - \varnothing 1,2 mm (Massivdraht)

$I_s = 250$ A, $U_s = 27,5$ V; $s = 25$ cm/min,
a-Maß = 5 mm, Porenfläche = 2,6 %

Figs 3 and 4: Penetration and fracture area in test no. 30.
Wire \varnothing - 1.2 mm (Solid wire).
Pore area = 2.6%

45783

V = 2:1



45782

V = 1:1

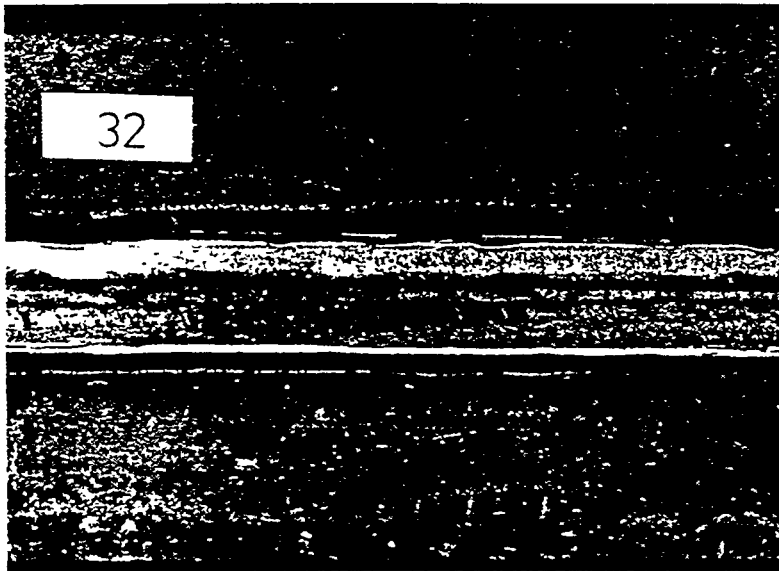


Bild 5 und 6: Einbrandform und Bruckbild zum Versuch 32,
Draht - \varnothing 1,2 mm (Fülldraht)

$I_s = 340$ A, $U_s = 30$ V, $s = 42$ cm/min
a-Maß = 5 mm, Porenfläche 6,5 %

Figs 5 and 6. Penetration and fraction area in test no. 32.
Wire \varnothing 1.0 mm. (Solid wire).
Pore area = 4.4%

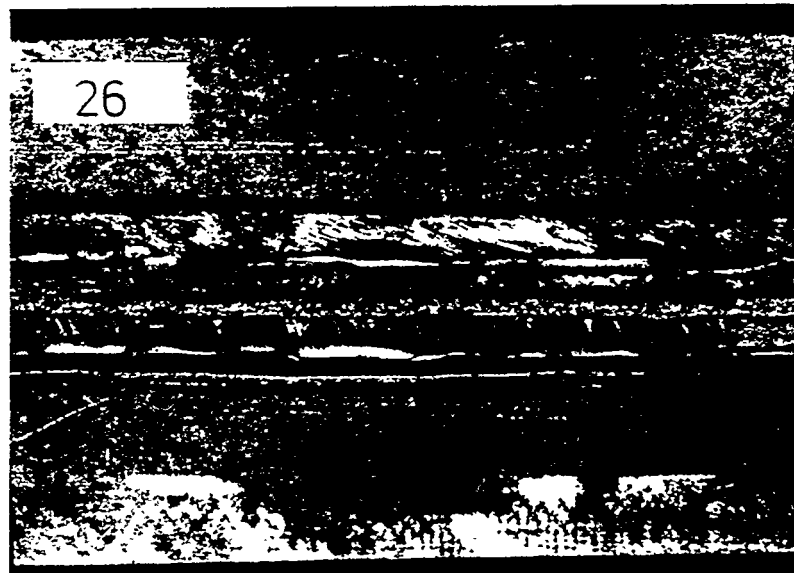
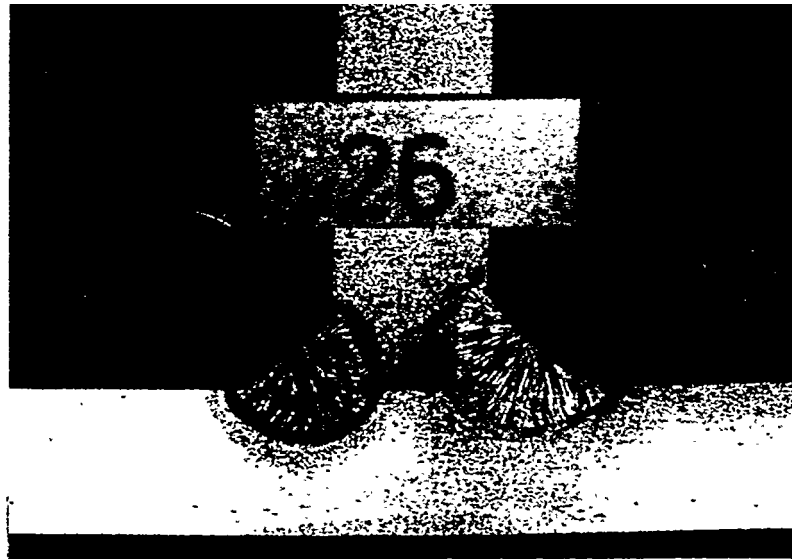


Bild 7 und 8: Einbrandform und Bruchbild zum Versuch 26

Draht - \varnothing 1,6 mm (Fülldraht)

$I_s = 280$ A, $U_s = 29$ V, $s = 34$ cm/min,

a-Maß = 4,5 mm

Porenfläche = 3,4 %

Figs 7 and 8. Penetration and fraction area in test no. 26

wire = \varnothing 1.6 mm (Solid wire)

Notification by the Federal Minister of
Labour, Bonn - III b 4 - 3745.81 - 3874/78 of
1/9/1978
(MAK-values 1978 - threshold limit value of toxic
substances).

Regulations for combustible liquids (VbF) of the regulations for prevention
of accidents VEG 23 of the Hauptverband der gewerblichen Berufsgenossenschaften³⁾
Regulations for work materials⁴⁾

1.4 Other standards

DIN 4678, Sheet 1 Determination of surface roughness parameters R_a , R_z , R_{max}
with electric stylus instruments; Basic data.

DIN 4769, Part 4 Roughness comparison specimens²⁾

DIN 18 200 Control (quality control) of construction materials,
construction components and construction designs;
General principles²⁾

DIN 55 151 Testing of paints and varnishes and similar coating
materials;
Cross-cut test on paint coatings and similar
coatings.

DIN 55 152 Testing of paints and varnishes and similar coating
materials;
Kardrel bending test on paint coatings and similar
coatings.

³⁾ To be obtained from Deutscher Fachschriften Verlag Braun GmbH & Co. KG,
Wiesbaden

⁴⁾ To be obtained from Carl Heymanns Verlag, Cologne

2 Shop primers

2.1 Function

It is the function of the shop primers in accordance with DIN 55 928, Part 5, to protect structural steel components during transport, storage and machining in the manufacturing works from corrosion. They are applied using special shop primer materials in continuous automatic plants where cleaning with abrasives and spraying take place. Shop primers are not prime coatings for paints. However, after careful patching they may be accepted as part of a prime coating.

2.2 General requirements

2.2.1 Requirements made on shop primer materials

Shop primer materials must be of a quality such that the requirements made on shop primers produced from them, as specified in DIN 55 928, part 5, draft September 1978, section 3.1.1, are fulfilled and correspond to the provisions on labour safety. Their tendency towards pore formation must be tested and controlled according to DVS Code of Practice 0501 by a competent authority according to section 3.

2.2.2 Requirements on the surface to be coated

- (1) The required standard level of cleanliness of the steel surface (see DIN 55 928 part 4, table 1) will depend on the shop primer materials used and on the expected corrosion stresses of the component.
- (2) With increasing peak-to-valley height, the pore formation during overwelding of the shop primer diminishes, whilst the corrosion protective effect deteriorates. The mean roughness index R_a according to DIN 4768 part 1 should therefore be between 6.3 and 12.5 μ m (see DIN 4769 part 4). R_a is tested in general by visual and touch comparison with appropriate roughness comparison specimens (see also DIN 55 928 part 4, section 5.2).

2.2.3 Requirements made on the shop primers

- (1) The thickness of the dry layer should be between 15 and 25 μ m.
- (2) The shop primer must assure corrosion protection under normal conditions of production and corrosion stresses over the period of manufacture - but for a minimum period of 3 months - unless otherwise agreed between manufacturer and processor.
- (3) The adhesive strength of the shop primer on steel - as measured by the cross-c test according to DIN 53 151 on sheets with a test layer thickness of the dry layer of 17 to 20 \pm 3 μ m - must reach the characteristic value $G_t \geq 0$. In the determination of the bending strength with the same test layer thickness, according to DIN 53 1 using a test mandrel diameter of 16 mm, no cracking or peeling of the shop primer should occur.

2.2.4 Requirements made on the welding processes, welding filler metals and auxiliary materials.

Welding processes, welding filler metals and auxiliary materials also exercise an influence on the tendency towards pore formation during the overwelding of shop^{pri}. They have to be selected by the welding undertakings; their suitability is to be checked within the scope of the extended proof of competence of the undertaking (see section 4.2).

2.3 Application of the shop primer materials

(1) The coating may only be carried out by undertakings having at their disposal skilled personnel, suitable continuous automatic plants for the cleaning with abrasives and spraying together with the appropriate testing equipment.

(2) The coating shall take place directly following the preparation of the surface and in such a manner that the thicknesses of layer according to section 2.2.3 (1) are maintained.

(3) The following characteristics in particular must be checked and recorded:

- * level of cleanliness of the surfaces
- * Peak-to-valley heights (check entry)
- * Shop primer materials used
- * Layer thicknesses (measurements every working day)

The records shall be preserved at least during the guarantee period and submitted on request.

(4) When rolling stock coated with shop primer is ordered, suitable arrangements regarding the expected corrosion stress and the planned welding processes are to be made with the supplier concerning:

- * requirements made on the coating surface (level of cleanliness, peak-to-valley height)
- * shop primer materials
- * thickness of shop primer layer within the scope of section 2.2.3 (1)
- * extent and demarcation of the internal control within the scope of section 4.3.1 (1) and (3).
- * written documentation (records) to be sent with goods.

3. Quality assurance of the shop primer materials.

3.1 General

The quality assurance shall be in conformity with DIN 18 200.

3.2 Requirements made on the shop primer material manufacturer

Undertakings manufacturing shop primer materials to be used within the scope of the present Code of Practice must have at their disposal suitable equipment for the preparation and testing of the shop primer materials and also the skilled workers required. The undertakings shall be subjected to a first test and to an internal and external routine control of their shop primer materials.

3.3 First test

(1) The first test is to be carried out at the request of the manufacturer of the material by the competent testing authorities (see foot-notes 5) and 6)). The request shall be accompanied by the technical data-sheet.

(2) The first test comprises :

- * the checking of the identity of the shop primer material against the technical data-sheet (specimen in Appendix 1) figures 3 - 10⁵⁾,
- * the testing of the tendency towards pore formation according to DVS Code of Practice 0501⁶⁾,
- * the testing of the MAK-values - threshold limit values of toxic substances⁶⁾.

(3) The results are to be summarized in a test certificate which should contain the following data (specimen see Appendix 2):

- * test certificate to the examination report no.....
- * designation of the shop primer material (result of identity check)
- * welding filler metal used,
- * statement confirming that the test has been carried out in accordance with the rules of the DVS Code of Practice 0501.
- * indication of mean total pore area
..... mm²
- * results of gas detection tests (at present CO, CO₂, NO, NO₂, COCl₂).

-
- 5) Competent testing authorities are at present: MPA Darmstadt; MPA Dortmund; BAM Berlin; MPA Baden-Württemberg; Otto-Graf-Institut, Stuttgart; Landesgewerbeanstalt Bayern, Nürnberg; Werkstoffprüfamt der Freien und Hansestadt Hamburg
- 6) Competent testing authorities are at present: Schweißtechnische Lehr- und Versuchsanstalten (SLV) Berlin, Duisburg, Hannover, Mannheim; Versuchsanstalt für Stahl, Holz und Steine der Universität Karlsruhe; Landesgewerbeanstalt Bayern, Nürnberg.

(4) Suitable shop primer materials are those with a mean total pore area $\leq 125\text{mm}^2$ determined according to DVS Code of Practice 0501.

3.4 Routine control

3.4.1 Internal control

The manufacturer of the material shall determine and record for each batch the Characteristics specially marked in the Technical Data-Sheet.

3.4.2 External control

The external control shall be carried out in general by the authority who has performed the identity check.

It shall comprise checking of the proper performance of the internal control, and checking the identity of the shop primer material. It must take place at least once annually and be confirmed in writing..

3.5 Marking on delivery of shop primer materials

(1) Following a successful first test and conclusion of the external control agreement, the following data are to be indicated on the package (drum) so as to provide proof of control:

- * Description of the product (product no., if available)
- * ~~Manufacturer~~
- * Name of external control authority
- * Batch no.
- * Date of manufacture

(2) The test certificate and the proof of external control shall be made available to the processor on request.

4 Quality assurance of the overwelding of shop primers

4.1 Requirements made on the steel construction undertakings

(1) Undertakings overwelding shop primers must have at their disposal an appropriately extended "Comprehensive form of proof" according to DIN 4100 for the intended fields of application, shop primer materials, welding processes and welding filler metals. To this end a works test is required.

(2) The skilled welding engineer entrusted with supervision of the welding according to DIN 4100 Supplementary sheet 1 has to provide ^{additional} proof within the scope of the works test (see section 4.2) of adequate ability for the overwelding

of shop primers. He shall be responsible for the taking of the required work test samples according to section 5 and for the quality of the welding work.

4.2 Works test, proof of competence

(1) The application for the proof of competence, or rather for the extension, shall be made to the authority competent for the "Comprehensive form of proof" according to DIN 4100. The execution of the proof of competence shall take place in consultation with one of the authorities mentioned in foot-note ⁶⁾

(2) This works test is to be carried out according to the standard principles of the approved testing authorities. It shall extend over the

- * operating equipment and apparatuses

- * personnel requirements

- * work test samples; their preparation, testing and evaluation according to specimen in Appendix 3

required within the scope of this Code of Practice.

(3) The results of the works test shall be recorded in a test report which must include the following items of information:

- * Scope of application

- * Base materials

- * Welding processes

- * Welding filler metals

- * Shop primer materials

- * Name of person charged with supervision of welding

(4) The test report shall form the basis for the extension of the "Comprehensive form of proof" by appropriate entries in the line "Limitations, extensions" of the certificate.

4.3 Routine control

To assure consistent quality of the welds during construction, a routine control by internal and external control bodies in accordance with DIN 18 200 is required.

4.3.1 Internal control

(1) During the coating work measurements of the coating thickness are to be carried out daily; see also section 2.3 (3) and (4).

(2) During the current steel construction work, test samples according to section 5.2 are to be prepared, tested and the results recorded according to the specimen in Appendix 3.

The extent of the work test samples is to be fixed so in consultation with the

external control authority according to section 4.3.2, that the actual range of application of the works is included and can be adequately assessed. In any case, a work test sample shall be prepared at least once every 4 weeks.

(3) The records must be preserved and presented to the external control authority on request.

4.3.2 External control

(1) The external control shall be carried out by the authority competent for the "Comprehensive form of proof". The authority must satisfy itself at least once annually by a random test of the proper performance of the internal control.

(2) The scope of the external control has to be increased, if defects in the internal control are discovered. In the individual case special arrangements may be made with the client.

4.4 Criteria for the assessment of the quality of the weld

(1) It shall be considered that proof of adequate quality of the welding for the construction has been provided, if the percentage pore area A_{pp} , determined in the work test samples according to specimen in Appendix 3 corresponding to section 5.3, complies with the following condition:

$A_{pp} \leq 7\%$ in components with predominantly static loading

A_{pp}

$A_{pp} \leq 4\%$ in components with not predominantly static loading;

this limit value is based on the assumption that the appearance of the fracture shows no chains of pores (accumulations of pores with pore distance \leq pore diameter d_p according to section 5.3 (2)). Such exceptional cases require a special assessment.

5 Principles for the uniform preparation, testing and evaluation of the work test samples

5.1 General

Fillet welds behave far more unfavourably in respect of possible pore formation during the overwelding of shop primers than butt welds. For this reason the examination and evaluation of pore areas in the weld is carried out on work test samples with fillet welds

5.2 Preparation

(1) Work test samples shall be prepared under normal production conditions (in particular observation of the welding parameters) by welders employed in construction work using the shop primer materials, the welding processes and

(2) The samples should be taken as far as possible from the rolling stock used (residual pieces remaining); any additions required should be allowed for in the planning stage. If this is not possible test specimens attached to the component, or else samples fabricated under identical conditions are to be used.

(3) The sheet thickness should be between 12 and 20 mm unless different thickness ranges are used predominantly in the construction work. The sheets are to be cleaned by abrasives, coated and trimmed (by shearing, flame-cutting or sawing) as in normal construction work.

(4) Shape and dimensions of the work test sample as shown in figure 1. By ^{means of} this work test sample all the forms of weld listed in DIN 18 800 part 1 table 6 are considered to be covered as well. If in the course of the construction work welds have to be carried out, for which a substantially less favourable behaviour with regard to pore formation must be expected, the appropriate sample types are to be selected in consultation with the external control authority.

Figure 1 Double fillet weld - work test sample (dimensions in mm)

- a ...weld
- b....edge of web
- c....welding direction
- d....initial piece
- e....test piece
- f....end piece

- * web and flange coated on both sides
- * fitted edge of web s sheared, sawn or flame-cut, uncoated or coated according to construction conditions.
- * weld fillet welds (1) and (2) in the specified sequence, single-pass, in horizontal position

- * produce groove ≥ 6 mm after welding
- * l_1, l_2 length of test pieces (evaluation distances)
- * initial and end pieces not to be evaluated.

(5) The work test samples shall be produced in the following dimensions according to welding process (see figure 1):

a) manual and semiautomatic welding processes:

length $L \approx 300$ mm
 initial piece $a \approx 60$ mm
 end piece $b \approx 40$ mm

b) fully automatic welding processes:

length $L \approx 600$ mm
 initial piece $a \approx 250$ mm
 end piece $b \approx 150$ mm

5.3 Testing and evaluation

(1) For the purpose of testing and evaluating, the work test sample is broken. The fracture should pass through the plane of the weld with the largest pore area (generally the bisecting line of the angle between web and flange). Otherwise the test is to be repeated or the remainders of these samples are to be examined by a different process (e.g. X-ray). The fracture surface with the greatest number of pores is to be evaluated. As a rule this will be the weld

(2)

(2) The number of pores are to be determined over a weld length of 100 mm and the individual pore ^{is to be} area measured. Thus, for example, the length and maximum width of each individual pore may be measured and, taking these two measurements as principal axes (D, d) of an ellipsis, the individual pore area may be calculated. Pores whose largest principal axis $D < 0.5$ mm are not considered.

The following data are to be determined for each test piece:

* number of pores n
 for pores with $D \geq 0.5$ mm

* individual pore areas $a_{p_i} = D_i \cdot d_i \cdot \frac{\pi}{4}$ in mm²

* total pore area $A_p = \sum a_{p_i}$ in mm²

* percentage pore area $A_{pp} = \frac{\text{total pore area} \cdot 100}{\text{weld fracture surface}} = \frac{A_p \cdot 100}{A_{BR}}$ in %

(3) If the percentage pore areas A_{pp} permissible according to section 4.4 are exceeded in a work test sample, two further work test samples are to be prepared, tested and evaluated. If these too do not comply with the aforementioned conditions, the external control authority is to be notified immediately.

Technical Data-Sheet for Shop Primer materials

- | | Desired value ¹⁾ | Actual value ²⁾ |
|--|-----------------------------|----------------------------|
| 1) Manufacturer | | |
| 2) Trade name | | |
| 3) Shade of colour | | |
| 4) Type of binder | | |
| 5) Content of binder in % by weight | | |
| 6) Type of pigment | | |
| 7) Content of pigment in % by weight | | |
| 8) Mixture ratio | | |
| 9) Density according to DIN 53 217 | | |
| 10) Processing time | | |
| 11) Diluent | | |
| 12) Viscosity as delivered according to DIN 53 211 | | |
| 13) Recommended thickness of dry layer | | |
| 14) Processing: | | |

Viscosity DIN 53 211 Pressure in bar Nozzle dia. mm

~~Compressed-air spraying:~~

~~Very high pressure spraying:~~

- 15) ~~Layering~~ stage 2 according to DIN 53 150 after.....minutes
- 16) ~~Cross-cut~~ test according to DIN 53 151
- 17) Flash point according to DIN 53 213
- 18) Danger class according to VbF of 18/2/1960
- 19) ~~Liable to marking~~ according to the Regulations for work materials
(edition May 1976) : yes - no ³⁾

Batch no. of test specimen:

The details written in italics under figures 3 to 10 are to be checked/determined and recorded during the identity check within the scope of the first test (DAST-Ri 006, section 3.3 (2)) and internal control (DAST-Ri 006, section 3.4.1).

¹⁾ Details to be provided by shop primer manufacturer

²⁾ Details to be provided by the competent authority for the identity check according to section 3.3 (2)

Testing authority according to foot-note 6

Test certificate

For the shop primer material.....
described in the Technical Data-Sheet..... by.....
- confirmed by certificate of identity no..... of
by the testing authority.....
the following test certificate is issued in accordance with our examination
report no..... of.....:

1) The shop primer material has been tested in accordance with DVS Code of
Practice 3531 with the base materials and welding filler metals/welding
processes listed in the following:
.....
.....

2) The mean total pore area wasmm²
The requirement of DAST-Ri 006, section 3.3 (4) for the shop primer
material has thus been fulfilled/not fulfilled ¹⁾

3) The gas detection tests gave the following values:

	Data in ppm			
	Carbon monoxide	Carbon dioxide	Nitrous gases	Phosgene
	CO	CO ₂	NO, NO ₂	COCl ₂
MAX-values (Threshold limit values of toxic substances) according to regulations	50	5000	5	0.1
Concentration measured				

1) Delete as applicable. Shop primer materials with a mean total pore area
are considered suitable

Work test sample according to section 5

Date of test:

DAST-R1 006, edition January 1980
Appendix 3

Cleaning with abrasives:

Standard level of cleanliness
Roughness (R_a)

Shop primer material

Shop primer material manufacturer
Description/thickness of layer
Undertaking carrying out coating⁺⁾

Welding:

Name material
Name of welder

Undertaking carrying out the welding

+) If the coating is carried out by a different manufacturer

a.... Faces: sheared, flame-cut, sawn; coated,
or uncoated (according to conditions of
construction)

b.... Weld ① a-5
(single-pass)

c.... Weld ② a-5
single-pass

d.... Welding direction

e.... Initial piece

f.... Test piece

g.... End piece

h.... Work test sample

Weld Test piece	Shielding gas	l/min	Welding filler metal	Ampere	Volt	Wire feed m/min	Evaluation/notes	Total pore area Percentage pore area
--------------------	---------------	-------	----------------------	--------	------	--------------------	------------------	---

2 test Work test Work test
ple 3 sample 2 sample 1

Welding engineer

Welding technician, welding specialist, welding foreman

Evaluator

DEUTSCHER VERBAND FÜR SCHWEISSTECHNIK e.V. (GERMAN ASSOCIATION FOR WELDING TECHNOLOGY)	Testing of pore-forming tendency when overwelding production coatings (FB)* on steel	Directive DVS 0501 (March 1976)	D V S.
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Replaces the 2nd issue from January
1968

This directive is the result of several years' work at SLV Luisburg. The required framework for this directive was established in accordance with an analysis of the tests laid down in data sheet DVS 0501, issue 1965. All details of the test have been reviewed in comprehensive test series, from the point of view of their effects on the results. A promotional consortium comprising the Ministry for Economics, Small Businesses and Traffic of North Rhine-Westphalia, industrial associations active in this area, acceptance organisations and manufacturers of lacquer bases and lacquers has financed this project and acted in a consultant capacity.

Contents:

- 1 General
 - 1.1 The term "Production coating (FB)"
 - 1.2 Scope of directive
 - 1.3 Purpose of directive
 - 1.4 Special features of test
- 2 Implementation of test
 - 2.1 Test specimens
 - 2.2 Application of coating and determination of coating thickness
 - 2.3 Welding of specimens
 - 2.4 Determination of porosity
- 3 Test report
- 4 Compilation of test results
- 5 Supplement

1 General

1.1 The term "Production coating (FB)"

Production coatings (FB) are coatings applied to freshly sand-blasted steel in accordance with the present state of the art, each coating layer having a thickness of about 15 to 25 µm. They are intended to ensure temporary corrosion protection until the end of production and should be suitable for overwelding. The requirements as regards protection against corrosion may vary according to the type and duration of the production process.

*Previously employed German term: Fertigungsanstrich (FA);
frequent international term: Shop primer.

1.2 Scope of directive

The directive applies to overwelding by the arc-welding process of production coatings of steel.

1.3 Purpose of the directive

The directive creates the condition for repeatable testing of the pore-forming tendency when overwelding production coatings on steel. It is intended to enable relative mutual comparison of the coating materials.

The directive can assist in the development of coating materials not susceptible to pore-formation, and accordingly also for the development of appropriate welding fillers and ancillary materials, provided that appropriate testing methods are employed.

It enables the user to carry out ^{his} own comparative studies.

It does not apply to shop testing (see supplement).

1.4 Special features of test

The test conditions laid down in the directive give rise, owing to the very narrow root opening, to very high porosity not usual in practice. However, the high degree of porosity is a necessary test condition, since it enables differentiation and repeatability. The test conditions specified apply to testing stations with appropriate equipment. As regards comparative studies at workshop level it should be borne in mind that deviations from this directive may lead to considerably different results. With all tests special attention must be paid to the type of root opening, for the latter affects the result to a considerable extent.

Coated side

Test specimen

2mm dia. copper wire

Jaws of vice

Fig. 1. Lap-welded specimen in vice.

2 Implementation of test

2.1 Test specimens

There is made of a lap-welded specimen as shown in Fig. 1. The dimensions of the specimens are as follows:

20 mm x 80 mm x 200 mm and
12 mm x 50 mm x 200 mm

By way of base metal use should be made of drawn C 10 in the form of bright flat steel as specified in DIN 1652. The parts shall have a smooth, plane, undamaged surface. Burrs, if any, along the longitudinal front edge should be carefully removed with the aid of a file. Prior to coating the parts must be degreased and cleaned with the aid of a solvent.

Altogether 8 specimens are required.

2.2 Application of coating and determination of coating thickness

Only one component of the specimen is coated to a thickness of 17 to 23 μm (dry layer thickness), as shown in fig. 1. If requested by the customer additional layers may be added. A tolerance of $\pm 3 \mu\text{m}$ is specified for the application. The coating must be uniform over the entire specimen surface.

The thickness of the coating should be measured with suitable instruments of conventional type and with adequate precision, on plane sheets having a thickness of at least 1 mm. In cases of doubt the thickness of the layer should be determined by microscope. The sheets should be coated in one pass, i.e. one sheet each as the first and last piece of the series. Ten measurements should be taken for every sheet in order to determine the mean values of the layer thickness. With both mean values within the above limits the total mean value may be calculated, but if this is not the case the coating must be rejected.

2.3 Welding of specimens

The specimens may be welded after a drying period of ten days at room temperature and at a maximum air humidity of 70%. They should be clamped in a vice over their entire length, the clamping force amounting to 10 kN. At the point indicated soft-annealed copper wires of 2 mm diameter should be inserted. The vice should be tilted to an angle of 45° so that welding can proceed in the gravity position.

Welding process:	MAGC fully mechanical
Current:	250 A
Voltage:	30 V
Welding rate:	30 cm/min
Shielding gas:	CO ₂ acc. to DIN 32 526
Shielding gas required:	15 ltr/min
Distance	
Contact tube -	
theoretical root point:	18 mm
Wire electrode:	Acc. to DIN 8559

Diameter:

1.2 mm

Chemical composition:

C : 0.08 to 0.15%

Si : 0.80 to 0.95%

Mn : 1.45 to 1.6%

P : \leq 0.025%

S : \leq 0.025%

The values for current, voltage, welding rate, shielding gas required and contact tube distance are subject to a tolerance of 5%. The electrical measuring equipment used may be subject to a class error of not more than 1%.

2.4 Determination of porosity

The welding seams should be broken at a temperature of about 150 to 250°C so that the pore boundaries are clearly visible. The break must occur along the angle bisectrix and if this is not the case the specimen must be rejected. The evaluation should take place subject to tenfold enlargement, the pore image being projected on a ground glass disc of about 200 mm diameter. The pore sizes are measured on the ground glass disc, ^{the} largest dimension of every pore being determined, as well as the largest dimension at right angles thereto. The shape of the pore is represented as an ellipsis with these two dimensions as the main axes, whereupon the pore area is calculated. Pores the maximum main axes ^{of which} without enlargement is equal to or smaller than 0.5 mm are not evaluated. The evaluation should cover a distance of 100 mm. 60 mm from the start and 40 mm from the end of the specimen should not be included in the evaluation.

The following data should be determined in respect of every specimen:

Number of pores

n

Total pore area

$F \text{ (mm}^2\text{)}$

Mean single-pore area

$\frac{F}{n} \text{ (mm}^2\text{)}$

3 Test report

A test report containing the following data is required in respect of every test:

☐ Principal

☐ Proprietary designation of production coating material

☐ Characteristic pigment base

☐ Characteristic binder base

☐ Chemical composition of specimen material and welding wire

☐ Thickness of applied layers (individual values and mean values)

Results of evaluation:

Number of pores	}	individual values and mean values
Total pore area (mm ²)		
mean single-pore area (mm ²)		

As regards the mean values, the 95% confidence intervals*) should be determined.

The mean values and confidence intervals should be stated as follows:

Number of pores and total pore area:

in integral numbers;

mean single-pore area and confidence intervals of mean values:

one place after the decimal point.

Other decimal places are not taken into account.

A statement is required, with the following wording:

"This test has been carried out in accordance with the rules in Directive DVS C501, issue 1976. The provisions contained in this directive have been observed. Application of these rules entails intense pore formation to a degree not usual in practice. However, for the purposes of the test, such intense pore formation is necessary since it enables differentiation and repeatability."

Date, name and address of testing institute.

Signature of executive in charge and of the person responsible for the test.

4 Correlation of test results

The testing institute prepares a bar diagram in which the test results (mean value of total pore area) are continuously entered without giving any names. This diagram shall be made available to any interested party, if required. It is intended to indicate the pore-forming tendency of the available production coating in connection with overwelding.

5 Supplement

Until the issue of a data sheet on shop testing it is advisable to make use of the appropriate sections in the data sheet DVS C501 "Richtlinien für das Prüfen der Überschweißbarkeit von Anstrichen auf Stahl" (Directives concerning the testing of steel coatings for suitability for overwelding), issue January 1968, adapting it as required. The relevant sections are given below in abbreviated form.

*) This value indicates with 95% certainty in which interval the mean value of the parent population is located.

5.1 Types of test specimen

Test specimens as shown in fig. 2 are used to test for pore-forming tendencies.

tacking tacking
coated uncoated

Fig. 2. Test specimen with double fillet weld

5.2 Preparation of test specimens

The test specimen blanks are produced by flame-cutting or sawing. The base is pretreated according to DIN 18 364, grade 3 (derusting grade). The feed-to-valley height of the surface must not exceed 50 μm .

5.3 Dimensions of test specimens

The length of the specimen depends on the extent of the test. The dimensions in fig. 2 are minimum values.

5.4 Tacking

The test pieces are tacked at the points shown in fig. 2. The face of the web plate must be straight and cut at right angles; it must be supported along its entire length on the plane surface of the flange plate.

5.5 Welding process and welding conditions

Welding shall proceed at the mean output rates for the welding process employed. The following rules apply:

5.6 Welding of test specimens

Table 1. Fillet weld thicknesses

	Double fillet weld specimen (fig. 2)
Arc-welding by hand	$a = 3.5 \text{ mm}$
Submerged arc-welding	$a = 6.5 \text{ mm}$
MIG-welding under CO_2	$a = 4 \text{ mm}$

5.7 Testing

With a specimen as shown in fig. 2 it is necessary first to remove that part of the web plate which is above the fillet welds along the cutting line A-A, fig. 3, for instance by flame-cutting. This is followed by a radiological examination as shown in fig. 4. To prove that faults can be identified at all, use should be made of the wire penetrometer DIN 62 Fe/10 ISO 16 as laid down

in DIN 54 109 sheet 1. With this test the image quality coefficient must amount to at least 12.

Source of radiation

Fig. 3.

Preparing the fillet welds for radiological testing.

Film

Fig. 4

Radiological test
(schematic drawing)

5.8 Non-standard test conditions

With special applications test conditions may be agreed which differ from this directive. Also the scope of the test may be adapted according to the given requirements. Where testing entails other welding processes this directive should be adapted as required.

5.9 Assessment of overweldability

The pore-forming tendency when overwelding a coating is assessed in respect of the longitudinal cross-sectional area of the pores in the 25 mm long weld. With this method the pores visible in the X-ray image are measured and the various cross-sectional areas added. The sum of the pore sizes found in the X-ray films should be multiplied by 1.5.

Grading	Sum of pore cross-sections in mm ²
0	0
1	1... 5
2	6... 15
3	16... 30
4	31... 55
5	56... 90
6	91... 130
7	131... 190
8	191... 250
9	251... 320
10	> 320

The seams of the coated and uncoated halves of the specimen welded first and last should be assessed separately.

To assess the overweldability of coating materials the grading of the coated half of the test specimen must be reduced by the grading of the uncoated half, with every weld.

Example:

Assessment of test specimen half	Gratings	
	Seam first welded	Seam last welded
Coated	7	8
Uncoated	1	0
Difference	6	8

Assessment of pore-forming tendency: 6/8.



SCHWEISSTECHNISCHE LEHR- UND VERSUCHSANSTALT DUISBURG



des Deutschen Verbandes für Schweißtechnik e.V.
— Städtlich anerkannt als Ausbildungs- und Prüfstelle für Schweißtechnik —
anerkannte Stelle für den Nachweis der Eignung zum Schweißen

Untersuchungsbericht

Nr. 79 35 104

1. Ausfertigung

für die Firma Chemulack

in 1000 Berlin 37

über Untersuchung Ihrer Fertigungsbeschichtung

"Chemulack Primer E"

und der MAK-Werte

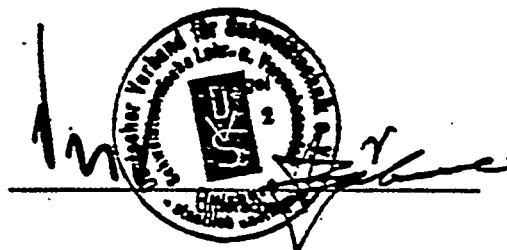
Der Bericht umfaßt:

7 Textseiten
- Bildseiten
- Anlagenseiten

Von dem Bericht wurden 4 Ausfertigungen ausgestellt und wie folgt verteilt:

1. Firma Chemulack, Berlin 37
2. Firma Chemulack, Berlin 37
3. SLV Duisburg
4. SLV Duisburg
5. ---
6. ---
7. ---
8. ---

Duisburg, 22. März 19 79
4.1.250 Gh/Kn



Dieser Bericht darf nur ungekürzt veröffentlicht oder an Dritte weitergegeben werden. Eine auszugsweise Benutzung für Veröffentlichungen jeder Art bedarf unserer schriftlichen Genehmigung.

Zu widerhandlungen können gerichtlich verfolgt werden.

Postanschrift:

Postfach 10 02 01, Bismarckstraße 85, D-4100 Duisburg 1

Telefon (02 03) 35 30 55

Telex-Nr. 8 551 331 slvd d



SCHWEISSTECHNISCHE LEHR- UND VERSUCHSANSTALT DUISBURG

DES DEUTSCHEN VERBANDES FÜR SCHWEISSTECHNIK e. V.

POSTFACH 100201 · BISMARCKSTRASSE 85 · 4100 DUISBURG 1 · ☎ (02 03) 35 30 55 · TELEX 8551 331 dsvd d

— Staatlich anerkannt als Ausbildungs- und Prüfstelle für Schweißtechnik —



Untersuchungsbericht Nr. 79 35 104

Auftraggeber: Chemulack GmbH & Co. KG
Goerzallee 303, 1000 Berlin 37

Auftrag vom: 12. Januar 1979

Prüfgegenstand: Prüfen der Porenneigung
entsprechend DVS-Richtlinie 0501
Ausgabe März 1976

Bezeichnung des
Fertigungsbeschichtungsstoffes:
Chemulack Primer E

Charakteristische Pigmentbasis:
Eisenoxidrot

Charakteristische Bindemittelbasis:
Epoxidharz

1. Chemische Zusammensetzung von Probenwerkstoff und Schweißdraht

	Angaben in Gewichtsprozent				
	C	Si	Mn	P	S
Schweißdraht	0,11	0,81	1,47	0,015	0,011
Grund- 12 x 50	0,09	0,24	0,42	0,017	0,019
werk- 20 x 80	0,09	0,23	0,38	0,010	0,018
stoff					

Schweißtechnische Lehr- und Versuchsanstalt Duisburg

des Deutschen Verbandes für Schweißtechnik e. V.

— Staatlich anerkannt als Ausbildungs- und Prüfstelle für Schweißtechnik —

79 35 104

Empfänger

Firma Chemulack, Berlin

Datum

22.03.79

Blatt

2

2. Applizierte Schichtdicke

Messung	Angaben in μm	
	erstes Feinblech	letztes Feinblech
1	17	20
2	20	18
3	17	23
4	19	19
5	21	19
6	19	21
7	19	20
8	19	20
9	19	17
10	21	20
Mittelwert	19,1	19,7
Gesamt-mittelwert	19,4	

Gemessen wurde mit einem Gerät, das nach dem magnetisch-induktiven Verfahren arbeitet.

Empfänger
Firma Chemulack, Berlin

Datum
22.03.79

Blatt
3

3. Ergebnisse der Auswertung

Proben-Nr.	Porenanzahl n	Gesamtporenfläche F (mm ²)	mittlere Einzelporenfläche F/n (mm ²)
1	20	9,98	0,49
2	11	4,09	0,37
3	12	3,99	0,33
4	15	5,75	0,38
5	20	10,98	0,54
6	22	6,34	0,28
7	16	6,84	0,42
8	13	6,02	0,46
Mittelwert	16	6	0,4
v _{DM} ¹⁾	21,3	31,3	17,5

1) v_{DM} = Vertrauensbereich des Mittelwertes auf dem 95 %-Niveau bezogen auf Mittelwert in %.

Nach dem derzeitigen Stand der Kenntnisse ist die Gesamtporenfläche "F" die aussagefähigste Größe.

Die mittlere Gesamtporenfläche beträgt:

6 mm².

Die Prüfstelle führt ein Säulendiagramm in das fortlaufend die Prüfergebnisse (Mittelwert der Gesamtporenfläche) eingetragen werden. Das Diagramm ist bei der Prüfstelle erhältlich.

Schweißtechnische Lehr- und Versuchsanstalt Duisburg

des Deutschen Verbandes für Schweißtechnik e. V.

- Staatlich anerkannt als Ausbildungs- und Prüfungsstelle für Schweißtechnik -

79 35 104

Empfänger

Firma Chemulack, Berlin

Datum

22.03.79

Blatt

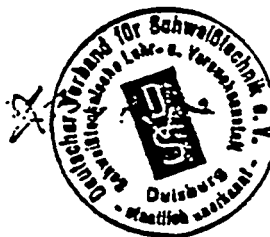
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4. Erklärung

Die vorliegende Prüfung wurde nach den Regeln des DVS-Merkblattes 0501, Ausgabe 1976 durchgeführt. Die Bestimmungen dieser Richtlinie wurden eingehalten.

Die Anwendung dieser Regel führt zu praxisunüblicher, starker Porenbildung. Aus Gründen der Differenzierbarkeit und Reproduzierbarkeit ist die starke Porenbildung aber prüftechnisch erforderlich.

Duisburg, 22. März 1979
Gh/Kn 4.1.250



Gulland

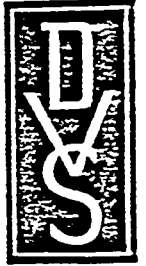


SCHWEISSTECHNISCHE LEHR- UND VERSUCHSANSTALT DUISBURG

DES DEUTSCHEN VERBANDES FÜR SCHWEISSTECHNIK e. V.

POSTFACH 100201 · BISMARCKSTRASSE 85 · 4100 DUISBURG 1 · ☎ (02 03) 35 30 55 · TELEX 8551 331 slvd d

— Staatlich anerkannt als Ausbildungs- und Prüfstelle für Schweißtechnik —



Untersuchungsbericht Nr.: 79 35 104

Auftraggeber:

Firma Chemulack Chemische Lackfabrik
Goertzallee 303, 1000 Berlin 37

Auftrag vom:

12. Januar 1979

Prüfgegenstand:

Gasspüryersuche beim Oberschweißen
der Fertigungsbeschichtung:

Chemulack Primer E

1. Beschichten - Messen der Schichtdicke

Es wurden drei gesandstrahlte Bleche (Entrostungsgrad: metallisch blank) der Abmessung 100 x 500 x 10 mm einseitig beschichtet.

Bei der Beschichtung und der Schichtdickenmessung wurde sinngemäß nach Punkt 2.2. der Richtlinie DVS 0501 (März 1976) verfahren.

Empfänger

Firma Chemulack, Berlin

Datum

22.03.79

Blatt

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2. Applizierte Schichtdicke

Folgende Schichtdicken wurden ermittelt:

	Angaben in um	
Messung	erstes Feinblech	letztes Feinblech
1	17	20
2	20	18
3	17	23
4	19	19
5	21	19
6	19	21
7	19	20
8	19	20
9	19	17
10	21	20
Mittel- wert	19,1	19,7
Gesamt- mittel- wert	19,4	

Gemessen wurde mit einem Gerät, das nach dem magnetisch-induktiven Verfahren arbeitet.

Nach einer Trocknungszeit von zehn Tagen bei Raumtemperatur und einer maximalen Luftfeuchte von 70 % wurden Auftragschweißungen mit Elektroden der Klasse B (R) 10 (DIN 1913, Ø 4 mm) hergestellt. Die Stromstärke war konstant und gleich 175 A. Die Schweißgeschwindigkeit lag bei 20 cm/min.

Empfänger

Firma Chemulack, Berlin

Datum

22.03.79

Blatt

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3. Vorgehen beim Gasspürversuch

Während des Schweißens wurden Gasproben mit einem Dräger-Gasspürgerät in unmittelbarer Nähe von Mund und Nase des Schweißers entnommen. Geprüft wurden die Gase:

Kohlenmonoxid	CO
Kohlendioxid	CO ₂
nitrose Gase	NO, NO ₂
Phosgen	COCl ₂

4. Ergebnisse der Gasspürversuche

Die für die einzelnen Gase ermittelten Konzentrationen sind in nachfolgender Tabelle aufgeführt:

	Angaben in ppm			
	Kohlenmonoxid	Kohlen-dioxid CO ₂	Nitrose Gase NO, NO ₂	Phosgen COCl ₂
MAK-Werte lt. Vorschrift in der BRD ⁺	50	5000	5	0,1
gemessene Konzentrationen	3	500	0	0

⁺Stand vom 01.09.1975

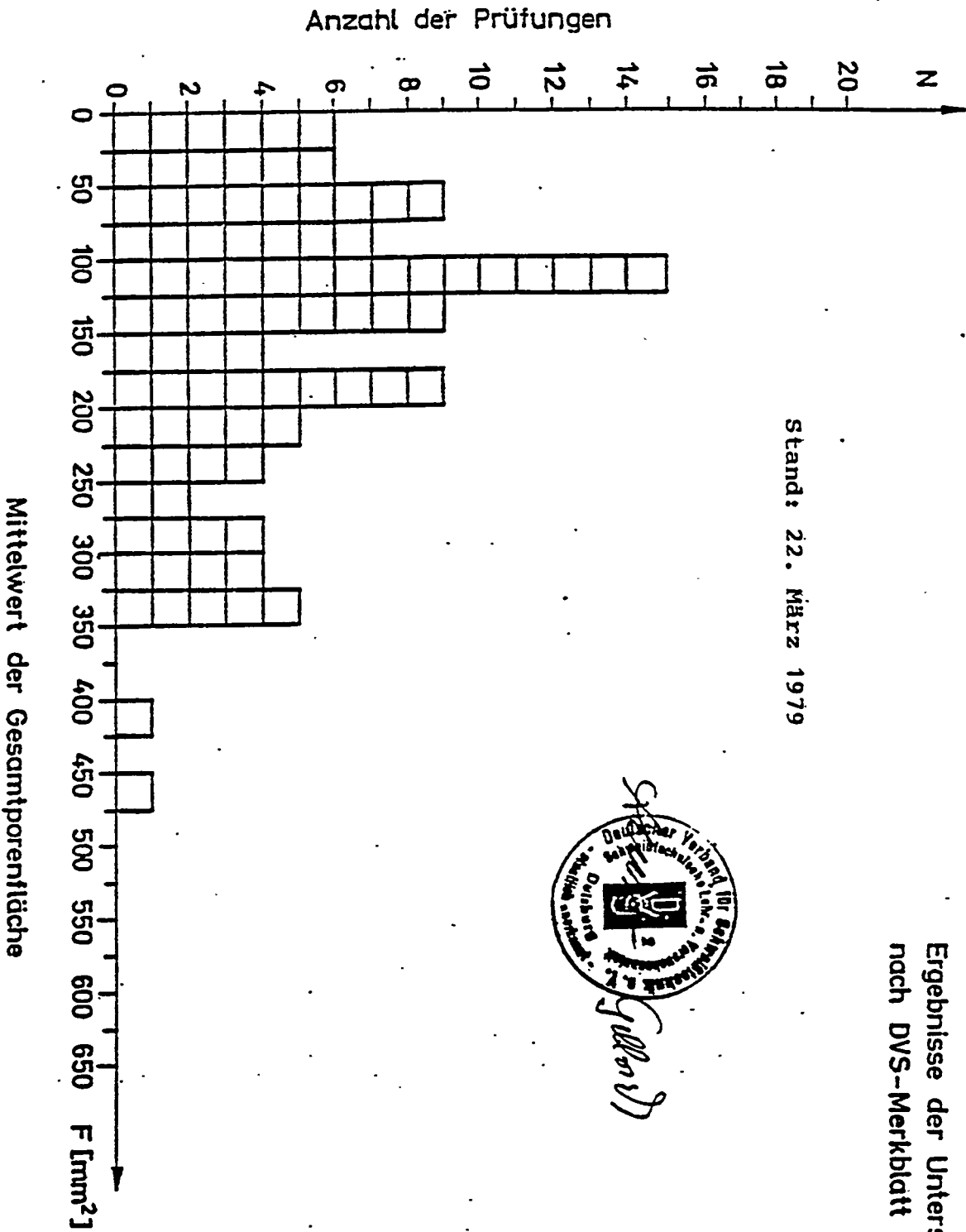
Die derzeit gültigen MAK-Werte wurden nicht überschritten.

Duisburg, 22. März 1979
Gh/Kn 4.1.250



**Ergebnisse der Untersuchung
nach DVS-Merkblatt 0501**

Stand: 22. März 1979





Lloyd's Register of Shipping

71 Fenchurch Street, London, EC3M 4BS

Telephone 01-709 9166

Telex 888379

Cables Committee, London EC3

Chemulack GmbH & Co. K.G.,
1000 Berlin,
Goerzallee 303,
Germany.

Please address further communications to The Secretary, and quote

Our Ref TSG/H/478/JCH

Your Ref

Date 15th December, 1976

c.c. L.R. Dusseldorf
c.c. L.R. Hamburg

Dear Sirs,

Prefabrication Primer
Chemulack - Primer E

The Society's Surveyors at Dusseldorf have forwarded a report on the above prefabrication primer.

The report has been examined and I have pleasure in stating that the results of the tests carried out on plates coated with Chemulack-primer E indicate that with the particular electrode used, the surface treatment produced no deleterious effect on the physical properties of the weld. There will, therefore, be no objection to the use of the paint on ships classed with the Society.

Chemulack-primer E has been added to the Society's List of Approved Prefabrication Primers.

The responsibility for ensuring that the welding is satisfactory rests with the Society's Surveyors at the Shipbuilding Yard, and it will be necessary for the Shipyard to satisfy the local Surveyors that, with the electrodes used in the Shipyard, the deposited metal is not impaired by the use of the primer. This will be verified by normal X-ray procedure during construction.

Yours faithfully,


for the Secretary

CMB/SF



SCHWEISSTECHNISCHE LEHR- UND VERSUCHSANSTALT DUISBURG

DES DEUTSCHEN VERBANDES FÜR SCHWEISSTECHNIK e.V.
41 DUISBURG 1 · POSTFACH 10 02 01 · BISMARCKSTRASSE 85 · FERNSPRECHER (02 03) 35 30 55



— Staatlich anerkannt als Ausbildungs- und Prüfstelle für Schweißtechnik —

Test Report Nr. 76 FF 226

Client: Chemulack GmbH & Co. KG
1000 Berlin, Goerzallee 303, Germany

Competent: Mr. Popper

Ref.: Determination of the influence of the primer coating
on the characteristics of welds

1. Introduction

Above mentioned company ordered to investigate the influence of their shopprimer on the properties of welds, in accordance with the rules of Lloyd's Register of Shipping (Chaper D, Section 2, 1976).

Additional, the following comments have been made:

The shopprimer is a:

2 component primer (redbrown,
bas: iron oxide, epoxy resin)

With the designation: Chemulack-Primer E

The recommended dry-film thickness of the coating is: $20 \pm 5 \mu\text{m}$

Empfänger

Chemulack, Berlin

Datum

18.10.76

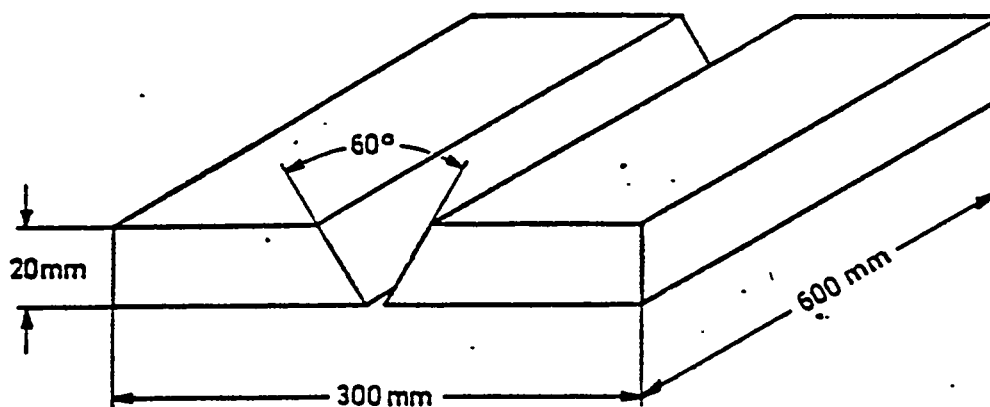
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2

2. Preparations

2.1. The test specimens

2.1.1. Dimensions



2.1.2. Material

Quality: H II

Properties and analysis: see acceptance (Werks-Abnahmezeugnis
gemäß DIN 50 049)

2.2. Coatings

Specimen 1 - coated in accordance with the manufactures instructions

Specimen 2 - coated to a thickness approximately twice the manufacturer's instructions

(Specimen 3 - uncoated)

Empfänger

Chemulack, Berlin

Datum

18.10.76

Blatt

3

Table: Coating Thicknesses

Measurement Nr.	Specimen	
	1	2
1	15	37
2	20	36
3	18	38
4	19	44
5	26	33
6	21	40
7	17	39
8	20	38
9	20	40
10	23	40
Average	19,9	38,5

Measuring instrument: Permascope (magnetic-inductiv)

2.3. Welding

Welding process: metal arc welding

Electrode: Kb IX s (DIN 1913) basic typ

Position: downhand

root runs: 170 Amp. - 4 mm Ø

filling passes: 220 Amp. - 5 mm Ø

cover passes: 200 Amp. - 5 mm Ø

capping passes: 170 Amp. - 4 mm Ø

Empfänger

Chemulack, Berlin

Datum

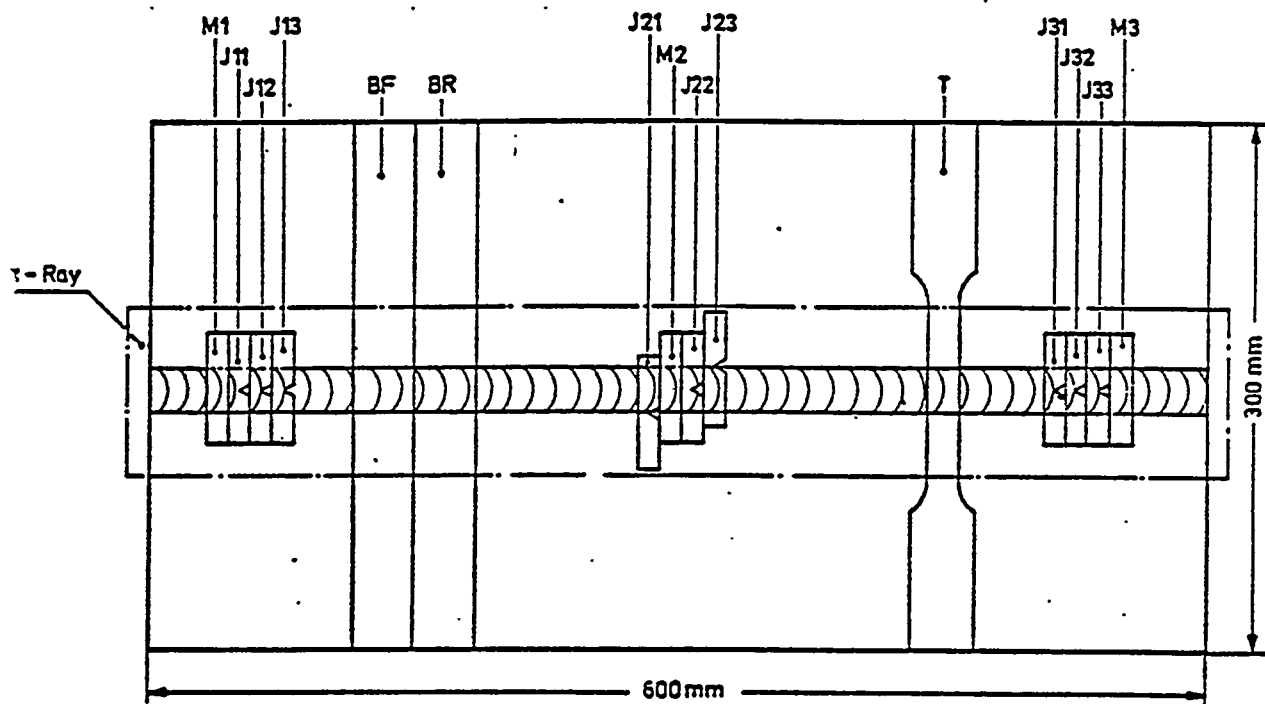
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Blatt

4

3. Investigations

Picture 2 is the layout of the test-specimens



M - Macrographs

BF - Face bend test

BR - Reverse bend test

I - Impact test

T - Tension test

(DIN 50121/ 30 x 20 x 300 mm)

(DIN 50 122/ ISO-V-notch)

(DIN 50 120/ 20 x 20 mm)

3.1. X-ray-tests

With the exception of single pores no defects could be determined in the radiographs. An influence of the paint could not be stated (see radiographs).

3.2. Macro sections

The photomacrographs (see pages 5 - 7) showed a normal build-up of the joints. Pores, cracks or other defects could not be determined.

Empfänger

Chemulack, Berlin

Datum

18.10.76

Blatt

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3.3. Bend tests

Face and reverse bend specimen bent to an angle of 180° round a former of three times the plate thickness didn't show any faults.

3.4. Impact tests

The results of the impact tests are included in the table below:
(test temperatur: $+20^{\circ}\text{C}$)

Weld Specimen No. 1		Weld Specimen No. 2		Weld Specimen No. 3	
Impact test No.	Impact energy (Joule)	Impact test No.	Impact energy (Joule)	Impact test No.	Impact energy (Joule)
J 11	13,9	J 11	13,7	J 11	15,9
J 12	15,7	J 12	14,7	J 12	15,9
J 13	17,7	J 13	14,7	J 13	15,4
J 21	19,3	J 21	13,2	J 21	16,5
J 22	15,7	J 22	15,6	J 22	16,1
J 23	13,9	J 23	15,7	J 23	13,7
J 31	21,6	J 31	15,5	J 31	19,0
J 32	20,5	J 32	18,1	J 32	16,6
J 33	18,6	J 33	14,7	J 33	15,7

An influence of the primer on the toughness of the joints could not be obtained.

Empfänger

Datum

Blatt

Chemulack, Berlin

18.10.76

9

3.5. Tension tests

The results of the tension tests are included in the table below:

Weld-specimen No.	yield point (N/mm ²)	tensile strength (N/mm ²)	total elongation at rupture %	Fracture in
1	305	425	23	base metal
2	306	429	28	base metal
3	291	413	24	base metal

An influence of the primer on the tension-test values could not be noted.

4. Summary

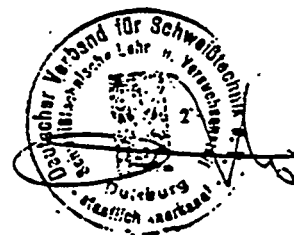
In order to determine the effect of the primer

Chemulack-Primer E

on welding, several tests have been carried out in accordance with the rules of Lloyd's Register of Shipping.

A negativ influence of the primer on weldability, the appearing of defects and the mechanical properties of the butt welds could not be appointed.

Duisburg, 18. Oktober 1976
Ot/Kn 4.1.250



Germanischer Lloyd

4/23, 25.05.

Hauptverwaltung Hamburg

Germanischer Lloyd Aktiengesellschaft
Postfach 1116 06, 2000 Hamburg 11

Vorsitzen 32, 2000 Hamburg 11
Telefon-Nr.: (0 40) 3 61 49-1
Tele-Nr.: 2 12 628 glnh d
Telegramm-Adresse: Klassenlloyd

Chemulack GmbH & Co. KG
Goerzallee 303

1000 Berlin 37

INGEGANGEN

1 6. MAI 1983

Ihr Zeichen

Ihre Nachricht vom

Tagebuch Nr.

Tele. Durchwahl

Hamburg

H/Wit-7/23

06.04.1983

15845/83 Rs/kh

3 61 49- 413

11.05.1983

In der Antwort bitte angeben

Betreff:

Unbedenklichkeitsbestätigung für Fertigungsbeschichtung (Shop-Primer)

Sehr geehrte Herren,

aufgrund der an der SLV Duisburg durchgeführten Prüfung der Porenneigung gemäß DVS-Richtlinie 0501 (3/76) und aufgrund des darüber vorliegenden Untersuchungsberichtes Nr. 79 35 104 vom 22.03.1979 bestätigen wir Ihnen hiermit, daß wir gegen die Verwendung Ihrer überschweißbaren Fertigungsbeschichtung (Shop-Primer)

Chemulack Primer E

im Geltungsbereich unserer Schiffbau-Schweißvorschriften keine Bedenken haben, soweit folgende Anwendungs- und Schweißbedingungen eingehalten werden:

Grundwerkstoffe:

Normal- und höherfeste Schiffbaustähle nach den Werkstoffvorschriften des GL.

Oberfläche:

Entrostungsgrad Sa 2 1/2 nach SIS 0559 00

Schichtdicke:

Durchschnittlich 0,020 mm, maximal 0,030 mm.

Schweißverfahren:

Alle schiffbaulichen, bei dem jeweiligen Anwender vom GL überprüften und zugelassenen Schweißverfahren, voll — mechanisches Doppelkehlnahtschweißen nur nach besonderer Verfahrensprüfung.

Wir behalten uns vor, beim Anwender stichprobenweise Arbeitsprüfungen in Form von unter Fertigungsbedingungen geschweißten Probestücken zu verlangen. Wir bitten, den Anwender hierauf und auf sorgfältige Einhaltung der o. a. Anwendungsbedingungen, insbesondere der Schichtdicke, hinzuweisen.

- 2 -

Seite 2 zum Schreiben an Chemulack GmbH & Co. KG, Berlin
vom 11.05.1983 Tagebuch Nr. 15845/83 Rs/kh


Seite 2 zum Schreiben an
vom 11.05.1983

Chemulack GmbH & Co. KG, Berlin
Tagebuch Nr. 15845/83 Rs/kh

Soweit zwischenzeitlich Identitätsprüfungen gemäß DAST-Richtlinie 006 von einer betriebsunabhängigen Prüfstelle durchgeführt worden sind oder durchgeführt werden, bitten wir um Hergabe der Prüfzeugnisse. Durch diese Identitätsprüfungen ist der Nachweis gleichbleibender Rezeptur und Qualität der laufenden Fertigung sowie deren Übereinstimmung mit dem ursprünglich geprüften Produkt zu erbringen.

Die mit Tgb.-Nr. 37660 Rs/Ts am 06.08.1976 gegebene Unbedenklichkeitsbescheinigung für den gleichnamigen Primer wird hiermit ungültig und wir bitten Sie, diese zu vernichten. Wesentliche Änderungen der Rezeptur des Primers bitten wir uns unaufgefordert mitzuteilen, sie bedingen eine neue Prüfung nach dem Merkblatt DVS 0501.

Mit freundlichen Grüßen

i.V.  i.V. 

American Bureau of Shipping

HAMBURG OFFICE

RODINGSMARKT 26 · 2 HAMBURG 11 · GERMANY

Telephone: 040-36 32 48 - Cable Address: "RECORD" · Telex: 214827

22 March 1977

Chemulack GmbH & Co KG
Goerzallee 303

Ref: HW/kr

1000 Berlin 37

In reply to your FS 4007 dated 21 March 1977

Gentlemen ,

in reply to your telex dated 21 March 1977 please be advised that we have no objections to the use of Chemulack-Primer and Chemulack-Primer e as a weldable primer or coating provided that it can be demonstrated to the satisfaction of the Surveyor in attendance at the shipyard, that it will not adversely influence the quality of the welds.

Therefore, using the same steel types and maximum coating thicknesses which are to be used in production, single fillet welds may be made and tested in accordance with NAVSHIPS Specification 0900-000-1000 paragraph 4.3.3.1.4. Double fillet welds may also be made and tested to the requirements of this same NAVSHIPS Specifications by alternately removing one weld completely and then testing the remaining weld.

Since the severity of the adverse effect of the twin fillet welding on the coated plates is dependent to same extent upon the spacing of the electrodes, the edge weld test will represent the most severe condition obtainable with twin fillet welding.

In the case, where double fillet welds fail to pass the edge weld tests, retests, using the exact same procedure which is to be used in making production welds, may be made and tested in accordance with the previously mentioned NAVSHIPS Specifications, copy of which is enclosed.

.../2

Chemulack GmbH & Co KG
Berlin

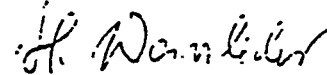
-2-

22 March 1977
HW/kr

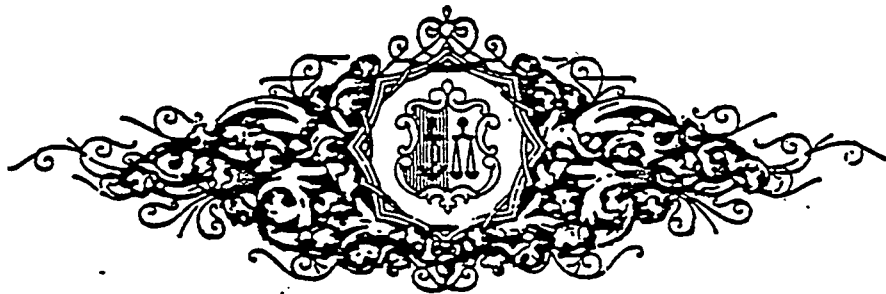
We would appreciate receiving a copy of the test results of Slvin Duisburg for our files, the final tests for acceptance of your primers should always done in the shipyards intending to use Chemulack primers.

No separate invoice would be submitted to you from our side if the tests required by NAVSHIPS Specification are being demonstrated to our attending Surveyors for a contract specifying ABS Classification.

Very truly yours
AMERICAN BUREAU OF SHIPPING


H. Weissleder
Principal Surveyor
for Hamburg

Encl.



DET NORSKE VERITAS

Established 1864

APPROVAL OF SHOP PRIMER

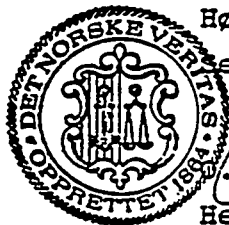
This is to certify that Chemulack G.m.b.H. & Co. K.G., Berlin

is granted our approval for Shop Primer

Chemulack - Primer E

The Shop Primer is approved for application on shot blasted steel plates and sections which are to be welded for use in ships classed or intended to be classed with Det norske Veritas.

The approval is based on results of fillet weld tests carried out in overhead position to prove that the amount of porosity is within the tolerance specified.



Høvik, 5th February 1980

Section for Materials Engineering

Næss
Næss

Head of Section

SP/279/IAL/EFr

SPECIAL CONDITIONS

The thickness of the primer coating to be applied is in practice to be as specified by the manufacturer, for this primer $\approx 27 \mu\text{m}$.

The approval is further granted on condition that no changes in the composition of the primer are made. If the composition is changed we must be notified and a sample of the new composition sent us for testing.

This approval is valid for 3 years and a new sample is to be forwarded us for re-testing before February 1983.

REFERENCE

Letter from DnV Hamburg, dated 8.10.79.

DnV Test Report No. 29110008/79/13/11

REMARKS

In this approval testing no tests have been made to check whether welding of plates with this shop primer coating may influence on the welders state of health.

The primer is noted in our list, "Filler Metals, Shop Primers and Welding Shops".



Det norske Veritas Research Division

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TELEX: 16 192 VERIT N

TECHNICAL REPORT

VERITAS Report No. 29110008/79/13/11	Subject Group
Title of Report APPROVAL TESTING OF CHEMULACH PRIMER E	
Client/Sponsor of project CHEMULACH GmbH & CO KG, BERLIN	
Work carried out by L. Rangul	

Date 30.01.1980	Department 13	Project No. 29110008/79/
Approved by M. Sandoy Sen. Res. Eng. <i>[Signature]</i>		
Client/Sponsor ref.		
Reporters sign. <i>[Signature]</i>		



On the 12th of October 1979 we received 1 set of Chemulach Primer E.

TEST PROCEDURE

Test plates were made of steel which complies with the specifications of Grade NV E-36. The procedure calls for 30 mm plate thickness.

The test plates were shot blasted, prior to pneumatic spraying of primer to a thickness of 27 μ m, as specified by the manufacturer. The primer coating thickness was measured on polished steel specimens, which were sprayed together with the test plates.

Coating thickness was measured with an electro-magnetic thickness measuring instrument.

The primed test plates were welded by 4 fillet welds to a cruciform joint. (See Fig. 1) Each fillet weld was carried out in one run, with a throat thickness of approximately 4 mm.



All welds were made in the overhead position using 4 mm diameter basic electrodes.

Welding current was 150 Ampere and the welding speed was approximately 150 mm/min.

After welding, the test assembly was cut into three equal test specimens as indicated in Fig. 1. The specimens were loaded until rupture in a tensile testing machine.

TEST RESULTS

Some pores were found on the fracture surfaces, the amount in question is, however, deemed to be insignificant, (i.e. < 5 % reduction of the weld section). The mechanical properties are not impaired.

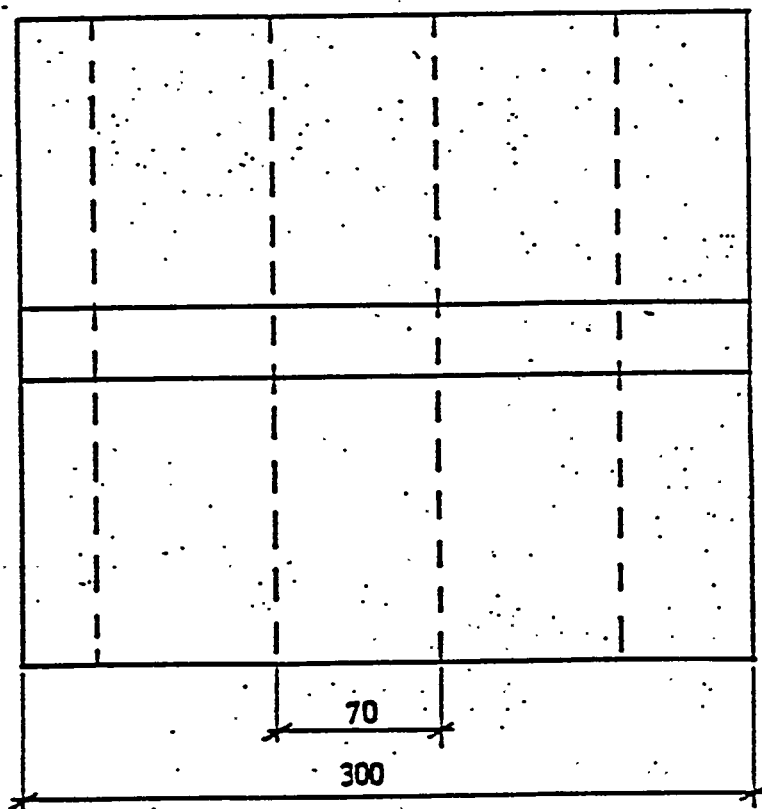
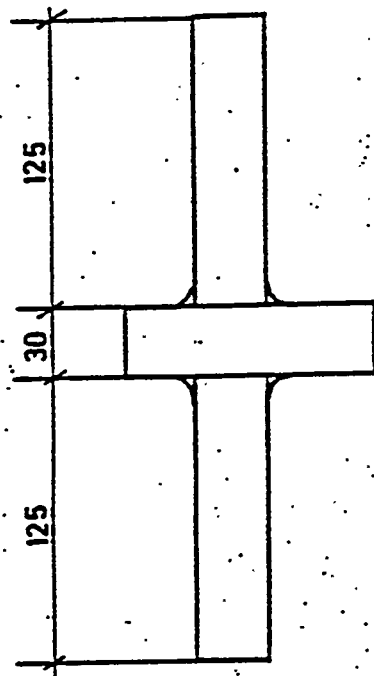


Fig. 1

Reference to part of this report which may lead to misinterpretation is not permissible.

Det norske Veritas has no liability for loss or damage caused by its organs, officers, employees, or others who act under assignment from the institution, regardless of whether such person has acted intentionally or negligently and irrespective of whether the loss or damage has affected a shipowning company, a shipyard or others who have requested the institution's assistance or any third party who without having any contractual relations with the institution, has acted or made arrangements in reliance on decisions made or information given by or on behalf of the institution.

TECHNISCHES MERKBLATT



Chemulack-Chemische und Lackfabrik G.m.b.H. & Co. KG - Goerzallee 303 - Berlin 37

CHEMULACK - WALZSTAHLKONSERVIERUNG

Roll-Steel Preservative

A modern method of preservation

Weldable by all standard welding processes

Maximum protection against corrosion

Immediately dry

Universal application

The following materials within our range of products are used for preserving rolled steel:

CHEMULACK-PRIMER

Mixture ratio 100 : 1 with hardener D 87
Base: Polyvinylbutyral

CHEMULACK-PRIMER E

Mixture ratio 100 : 40 with hardener D 151
Base: Epoxide resin

50 million m² steel preserved with CHEMULACK-PRIMER

A proof of the trust placed in us by our clients

Time-proven for steel structures as well as sheet steel for ship building and the motor industry

CHEMULACK-PRIMER and CHEMULACK-PRIMER E

2 qualifies for T process. No problems encountered with welding or heat treatment of primed surface

Immediately after sand-blasting rolled steel can be preserved with CHEMULACK-PRIMER. This produces a surface protected against corrosion which can then be painted within a short time with almost any kind of paint

TECHNISCHES MERKBLATT



Chemulack - Chemische und Lackfabrik G.m.b.H. & Co. KG - Goerzallee 303 - Berlin 37.

CHEMULACK - WALZSTAHLKONSERVIERUNG

Rolled Steel-Preservative

A modern method of preservation.

Weldable by all standard welding processes.

Maximum protection against corrosion.

Immediately dry.

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50 million m² steel preserved with CHEMULACK-PRIMER.

A proof of the trust placed in us by our clients.

Time-proven for steel structures as well as sheet steel for ship building and the motor industry.

CHEMULACK-PRIMER and CHEMULACK-PRIMER E.

2 qualities for 1 process. No problems encountered with welding or heat-treatment of primed surface.

Immediately after sand-blasting rolled steel can be preserved with CHEMULACK-PRIMER. This produces a surface protected against corrosion which can then be painted within a short time with almost any kind of paint.

The following materials within our range of products are used for preserving rolled steel:

1. CHEMULACK-PRIMER
Mixture-ratio 100 : 1 with hardener D-87
Base: Polyvinylbutyral
2. CHEMULACK-PRIMER E
Mixture-ratio 100 : 40 with hardener D-151
Base: Epoxide resin.

All materials can be processed by the following methods:

- a) airless electrostatic
- b) airless
- c) electrostatic
- d) air

All normal spray systems can be used.

When supplied as a two-component material the shelf-life is practically unlimited. Processing is simple because we supply the specific quantity of hardener at the correct ratio for every Hobcock Chemulack-Primer.

Chemulack primers are universally applicable. Their field of use extends from ship building to steel skeleton building construction. They have also produced excellent results when used with a wide variety of welding methods. Subsequent painting with almost all types of paint at present of the market is also possible.

Zinc dust primers are supplied by us for rolled steel preservation in the following qualities:

CHEMUZINC G 9 79/33 as single component material,

CHEMUDUR-CONTACT-ZINC-DUST-PRIMER G 9 48/29 as two component zinc dust paint.

Mixing ratio 100 : 5 with hardener D 12

The zinc dust paints are easy to weld and they offer excellent protection against corrosion. They conform with Federal Rail Regulations in accordance with TL 918 304 and TL 918 333.

TECHNICAL INFORMATION

on CHEMULACK-PRIMER and CHEMULACK-PRIMER E

Contents:

- I. Paint type
- II. Methods of application
- III. Life
- IV. Paintability with other paints
- V. Economy
- VI. Further processing features

I. Paint Type:		CHEMULACK-PRIMER	CHEMULACK-PRIMER E
1. Paint type:	Flash point above 21 °C	Flash point above 21 °C	Flash point above 21 °C
	Flash point below 21 °C	Flash point below 21 °C	Flash point below 21 °C
2. Binding agent base:	Polyvinylbutyral-phenol resin		Epoxy resin
3. Pigment base:	Iron oxide red		Iron oxide red
4. Thinner:	VD 141 with flash point above 21 °C		VD 65 with flash point above 21 °C
	VD 159 with flash point below 21 °C		VD 170 with flash point below 21 °C
5. Colour:	red-brown		brown
6. Viscosity:	20 sec. \pm 3 at 20 °C		17 sec. \pm 3 in mixture at 20 °C
7. Flash point:	above 21 °C		above 21 °C
	below 21 °C		below 21 °C
8. Specific gravity:	1 \pm 0,05		1,1 \pm 0,05 in mixture
9. Shelf-life:	at least 1 year		at least 1 year
10. Storage temp.:	room temperature down to -25 °C without harm		room temperature down to 0 °C without harm
11. Storage temp. with hardener added:	Approx. 3 - 4 weeks, mixing ratio 100:1		approx. 16 hours, mixing ratio 100:40 at 20 °C
12. pH-consistency as per DIN 53 168:	pH 12 to pH 14 for long period		

II. Methods of Application

CHEMULACK-PRIMER and CHEMULACK-PRIMER E can be applied by all existing spray processes. The following information applies for application by means of preservation plants.

1. Airless spraying: All equipment can be used, spray nozzle depending on size of object.
2. Airless electrostatic spraying: All trade-brand systems can be used.
3. Electrostatic value: The material can be applied by airless-electrostatic or by prely electrostatic techniques.

4. Spraying viscosity: Chemulack-Primer 20 sec. + 3
Chemulack-Primer E 17 sec. + 3
5. Spray mist development: Slight, depending on plant
6. Odour pollution: no odour
7. Safety precautions: the safety precautions depend on the particular provisions laid down by Trade Associations
8. Speed of application: 0,5 to 8 m. With these values the specific object and the possible use of other nozzles must be taken into account. In particular cases the speed may be reduced or increased.
9. Influence of moisture: Spray application can be employed at all normal relative humidities (max. 90 %)
10. Degree of preheating of material: Depending on plant and speed of application.
11. Coverage per unit volume: Excellent
12. Porousness: non-porous coat
13. Coating thickness: 20 my + 5 depending on choice of spray nozzle. Special setting if increased coating thickness is desired.
14. Type of supervision and adherence to prescribed coating thickness: The coating layer can only be measured by means of a reference plate which must run through the spraying plant together with the object to be coated. It is a well known fact that reliable measurement of the coating thickness is not possible with sand-blasted surfaces.
15. Drying under normal conditions: At a coating thickness of 25 my the primers are dust resistant dry after 2 - 5 minutes. After 5 - 10 minutes they are resistant to manual contact.
16. Drying with preservation plants: As a result of preheating of the material and heating of the sheet, the primers permit manual contact after 1 minute or 30 seconds at a coating thickness of 25 my.
17. Drying time prior to next coat: Approx. 1 hour

18. Demands place on surface roughness of steel: The depths of roughness should, as 1st normal, not exceed 60 μ m. A metallurgically clean surface must be achieved by blasting.

III. Untreated life

Up to 10 months depending on the conditions, in accordance with rules issued by German Steel Construction Association (Deutscher Stahlbau-Verband).

IV. Permissible overcoating with other paints

Chemulack primers can be coated with the following materials:

- a) Oil paint
- b) Synthetic resin paints
- c) Chlorinated rubber paints
- d) Vinyl paints (not all types)
- e) 2-component epoxide-resin paints
- f) Tar epoxide resin paints (2-components)
- g) Cold bituminous paint
- h) Hot bituminous paint
- i) Cement wash
- j) Non-drying grease paints
- k) Undercoat, bitumen base
- l) Undercoat, latex paint
- m) Top coats, bitumen base
- n) Top coats, latex
- o) Top coats, Neoprene
- p) Top coats, Epoxide resin

V. Economic considerations

	CHEMULACK-PRIMER	CHEMULACK-PRIMER E
	depending on setting	
1. Solid in %	Approx. 26 - 30	Approx. 44 - 53
2. Specific gravity of solid	Approx. 2	Approx. 2.2
3. Theor. yield at 20 μ m	Approx. 6.5 - 7.5 qm/l	Approx. 11.5 - 15.5 qm/l
4. Solid volume	Approx. 130 - 150 ccm/l	Approx. 230 - 310 ccm/l

V1. Further processing

- | | |
|---|--|
| 1. Demands placed on primed surfaces prior to further painting: | Dirty primer surfaces must be suitably cleaned with a corresponding cleaning agent (e.g. white spirit) |
| 2. Behaviour towards mechanical damage: | The material is impact and shockproof. Weld-seams and damaged spots must be re-primed. |
| 3. Welding and heat treatment: | Distinct edge arising after heat treatment. |
| 4. Method of removing heat-treatment residues in baking plants for later priming: | By wire brush, by sand blasting. |
| 5. Odour pollution during heat-treatment and welding: | The MAK-values are not exceeded with these agents (See certificate). |

DELIVERY FINISH':

Tropicalised thick primer coating is most suitable as a delivery finish. This quality possesses extremely high resistance to corrosion, weathering and time (see technical information). The coverage yield at a coating thickness of 40 μ m amounts to approx. 8 - 9 m^2/kg and thus offers an extremely favorable price-to-performance ratio in practice. Delivery colours may be as follows:

Reddish-brown	- G 4 458/23
Grey	- G 3 894/23
Green	- G 7 476/538
Orange	-G 2 529/23

Also as per Federal Rail Specification in accordance with Material No. 588.20.35 - G 7 232/23 and in accordance with Material No. 588.20.36 - G 5 162/88 as well as Special Export Quality G 4 497/23. The pigmentation in this case contains zinc chromate whereas the other above-listed materials contain other rust-inhibiting pigments. The materials quoted under "Finish Coats, Zinc Dust Paints" can likewise be used for protective delivery finishes if the corresponding layers are applied.

Final Coat:

As a result of the fact that we have developed new synthetic paints, it is recommended that use should be made of our Chemufix Synthetic Coating. This material can be applied by airless processes in one single operation

Up to a thickness of Coating of 50 my.it possesses extremely good resistance data for maritime and industrial atmospheres and is superior to all traditional oil and synthetic resin paints. If special regulations should exist with respect to the final coat, traditional synthetic resin paints such as Chemulux-Lackfarbe paint can of course also be used as well as oil and synthetic resin based paints in accordance with Federal German Rail stipulations. Four special applications Chemulack primers can also be coated directly with our epoxide tar-epoxide, acrylic and DD-base Chemudur-contact-paints with suitable composition.

C E R T I F I C A T E S

Tests on welding and cutting characteristics of sheet metal issued by Schweißtechnische Lehr- und Versuchsanstalt, Duisburg.

Report issued by Lloyd's Register of Shipping.

Licence granted by Det Norske Veritas.

Test Certificate issued by Baustoffprüfamt der Freien- und Hansestadt Hamburg on flammability Resistance measured by combustion channel method.

Weather Exposure Tests on Paints for Corrosion Inhibition issued by Freie und Hansestadt Hamburg, Strom- und Hafenbau.

Licence granted by See-Berufsgenossenschaft for Kauffahrteischiffe und Fischerei fahrzeuge.

Test Report on Determination of MAK-Values for Welding of Painted Sheet Steel for Chemulack-Primer drawn up by Institut für Lackprüfung, Gießen.

Test Report on Determination of MAK-Values for Welding of Painted Sheet Steel for Chemuzink.

Suitability Certificates issued by German Lloyd.

Test Certificate issued by Bundesanstalt für Materialprüfung Berlin in accordance with Provisional Rules for Choice of Finish Paints for Rolled Steel Preservation in Steel Construction.

Test Report issued by Schweißtechnische Lehr- und Versuchsanstalt, Duisburg.

Results of Examinations conforming to DVS Sheet 0501 (Column Diagram).

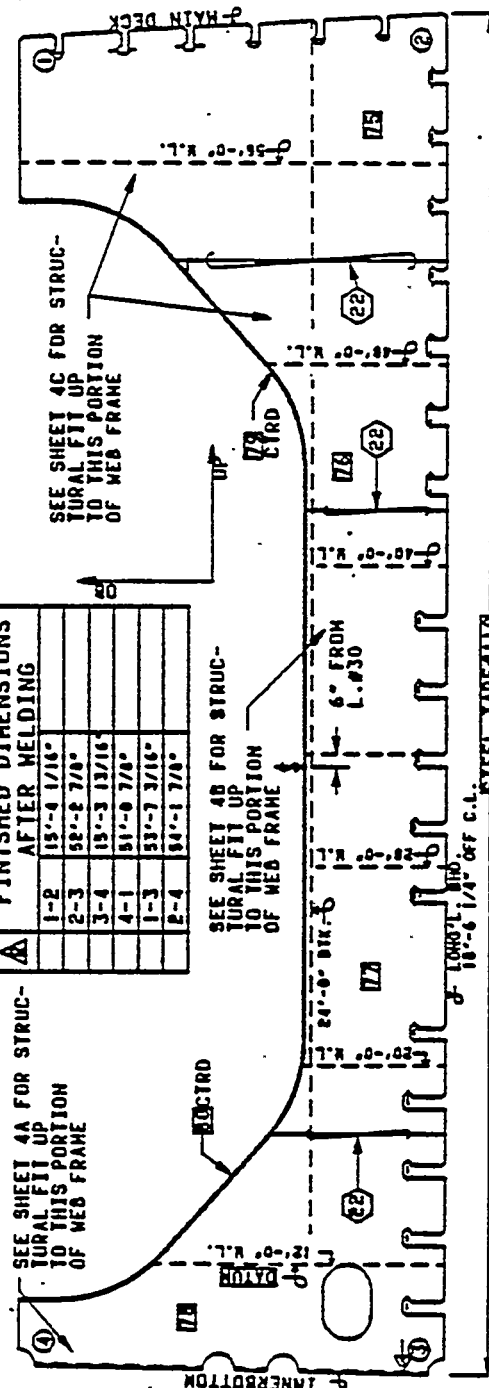
Annex 2

Drawings

Layout "A", Web Line .	734.073.48-A
Layout "B", Web Line	734.073.47-A
Layout "C", Web Line	734.073.50-A
Layout "D", Web Line	734.073.49-A
Beam Positioning and Welding Machine	763.063.51-3
Transport Table	763.063.55-B
Shotblast for Beams	763.063.59-B
Beam Manipulator	763.063.63-B
Preliminary assembly drawing "A"	763.063.44-A
Preliminary assembly drawing "B "	763.063.45-A
Preliminary assembly drawing "C"	763.063.46-A
Preliminary assembly drawing "D"	763.063.47-A
Preliminary assembly drawing "E"	763.063.48-A

PARTS LIST					PARTS LIST					PARTS LIST				
LM	PIECE NO.	QTY	MATERIAL	GRADE	LM	PIECE NO.	QTY	MATERIAL	GRADE	LM	PIECE NO.	QTY	MATERIAL	GRADE
1	23-3-2-75	1	15/32" PL	AH32	1	23-3-2-87	1	5/8" X 6" FB	A	1	23-3-2-99	1	5/8" X 6" FB	A
2	23-3-2-76	1	15/32" PL	AH32	1	23-3-2-88	1	5/8" X 6" FB	A	1	23-3-2-100	1	5/8" X 6" FB	A
3	23-3-2-77	1	15/32" PL	AH32	1	23-3-2-89	1	5/8" X 6" FB	A	1	23-3-2-101	1	5/8" X 6" FB	A
4	23-3-2-78	1	15/32" PL	AH32	1	23-3-2-90	1	5/8" X 6" FB	A	1	23-3-2-102	1	5/8" X 6" FB	A
5	23-3-2-79	1	7/8" PL	AH32	1	23-3-2-91	1	5/8" X 6" FB	A	1	23-3-2-103	1	5/8" X 6" FB	A
6	23-3-2-80	1	7/8" PL	AH32	1	23-3-2-92	1	5/8" X 6" FB	A	1	23-3-2-104	1	5/8" X 6" FB	A
7	23-3-2-81	2	5/8" X 6" FB	A	1	23-3-2-93	2	5/8" X 6" FB	A	1	23-3-2-105	1	5/8" X 6" FB	A
8	23-3-2-82	1	5/8" X 6" FB	A	1	23-3-2-94	1	5/8" X 6" FB	A	1	23-3-2-106	1	5/8" X 6" FB	A
9	23-3-2-83	1	5/8" X 6" FB	A	1	23-3-2-95	1	5/8" X 6" FB	A	1	23-3-2-151	1	5/8" X 6" FB	A
10	23-3-2-84	1	5/8" X 6" FB	A	2	23-3-2-96	2	5/8" X 6" FB	A	2	23-3-2-152	2	5/8" X 6" FB	A
11	23-3-2-85	1	5/8" X 6" FB	A	1	23-3-2-97	1	5/8" X 6" FB	A	1				
12	23-3-2-86	1	5/8" X 6" FB	A	2	23-3-2-98	2	5/8" X 6" FB	A	1				

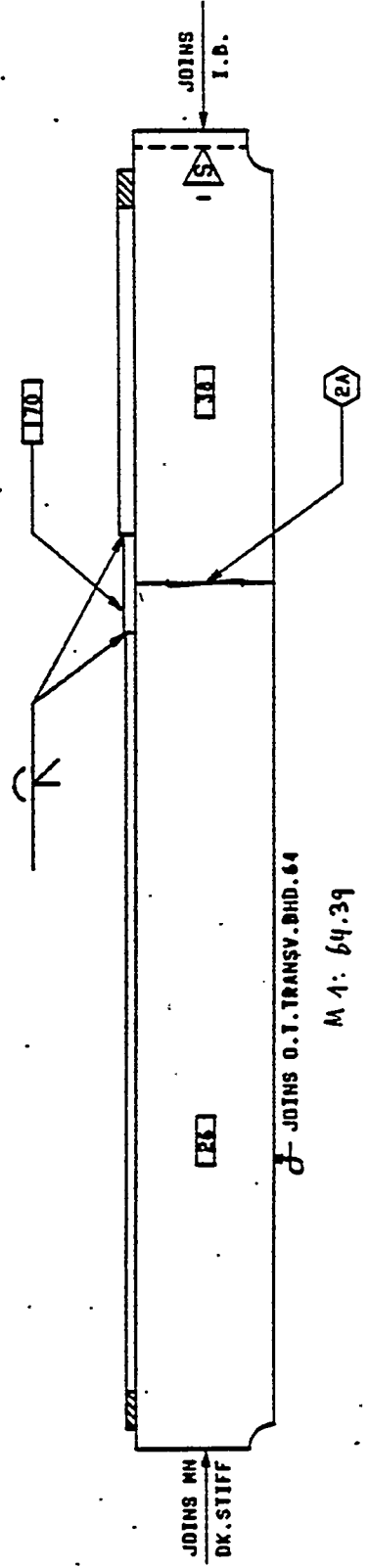
FINISHED DIMENSIONS AFTER WELDING		
1-2	15'-4 1/16"	
2-3	58'-2 7/8"	
3-4	15'-3 13/16"	
4-1	51'-0 7/8"	
1-3	53'-7 3/16"	
2-4	54'-1 7/8"	



TYP WELD	SIZE	DRAWN BY	JOB	TRANSV. WEB FR-65 PORT	ASI DWG NO
1/4" ∇ 6/35	B	H. TRAVIS	C1-15		PSU 23-3-2
		FILED BY	REVISION		SH NO 4

NOTES

PARTS LIST				
LN	PIECE NO.	QTY	MATERIAL	GRADE
1	23-1-65-26	1	FAB TEE	AN-32
2	23-1-65-38	1	FAB TEE	AN-32
3	23-1-65-170	1	3/4" PLATE	AN-32

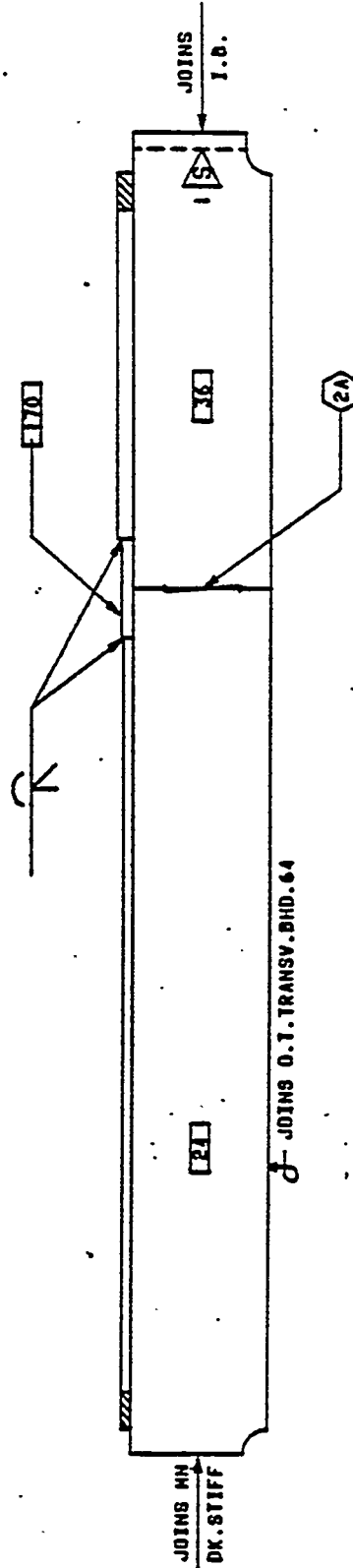


JOINS O.T. TRANSV. BHD. 64

M 1: 64.39

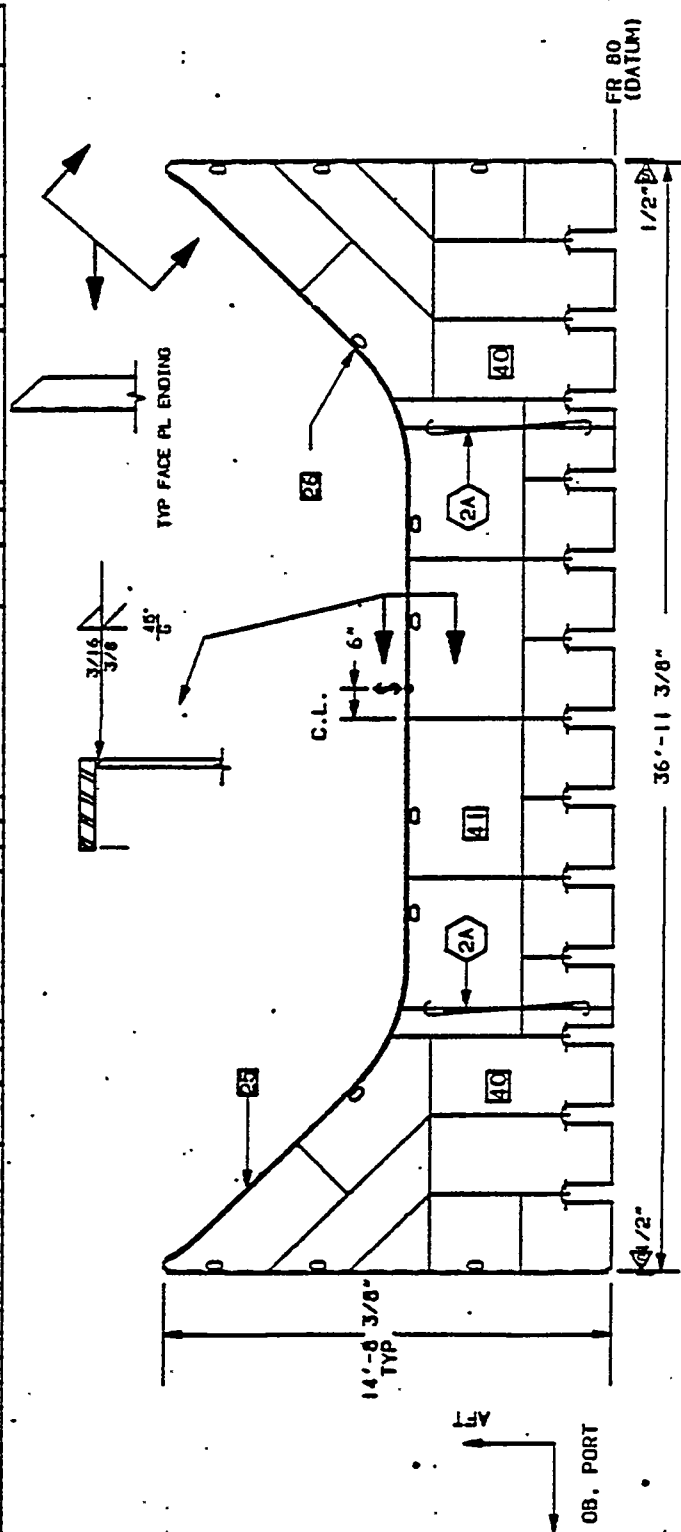
m ~ 428788

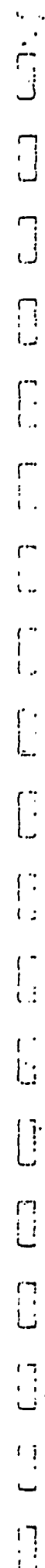
PARTS LIST				
QTY	PIECE NO.	MATERIAL	GRADE	
1	23-1-66-24	FAB TEE	AH-32	
2	23-1-66-26	FAB TEE	AH-32	
3	23-1-66-170	3/4" PLATE	AH-32	



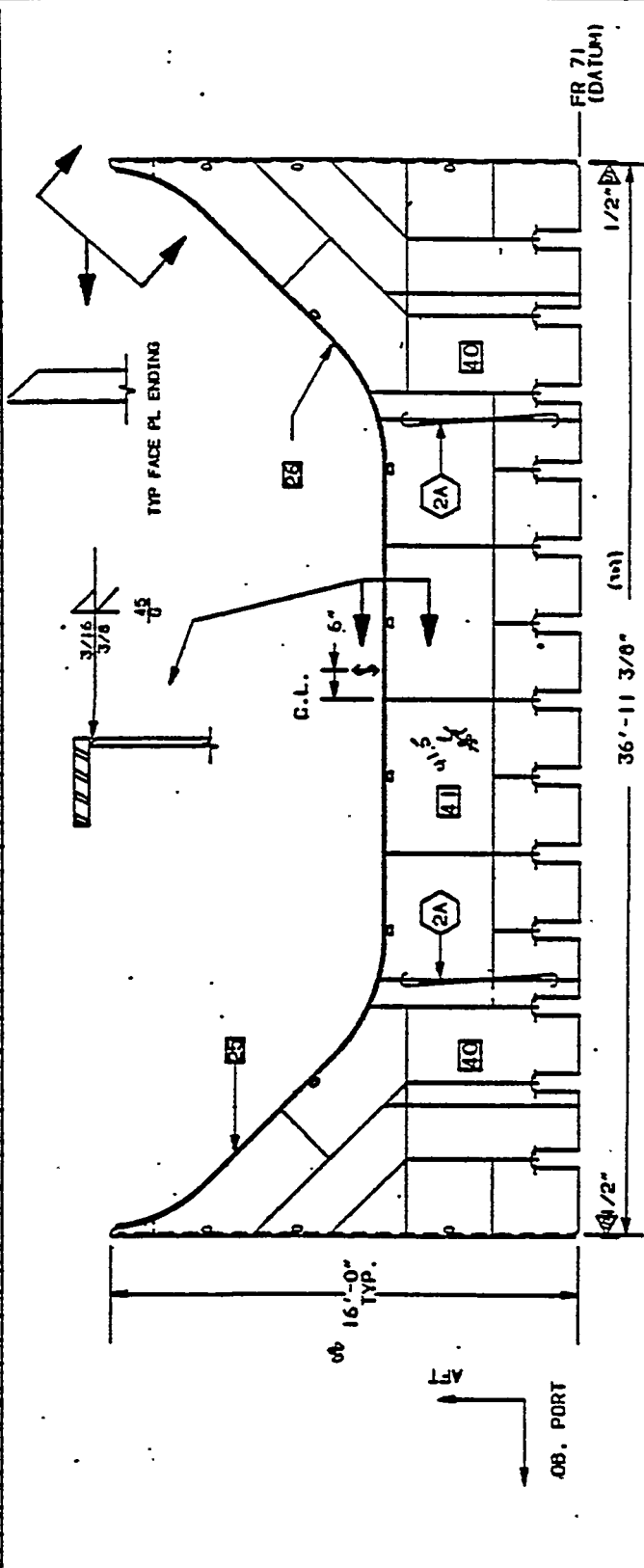
TYP WELD	SIZE	DRAWN BY	JOB	VERTICAL STIFF. #	ASI DHG NO
	B	M. TRAVIS	C1-15	LONG L. #10	PSU 23-1-66
		CHECKED BY	REVISION		SH NO 32
		M. G. ALLIANCE			
		3-7-82			

PARTS LIST




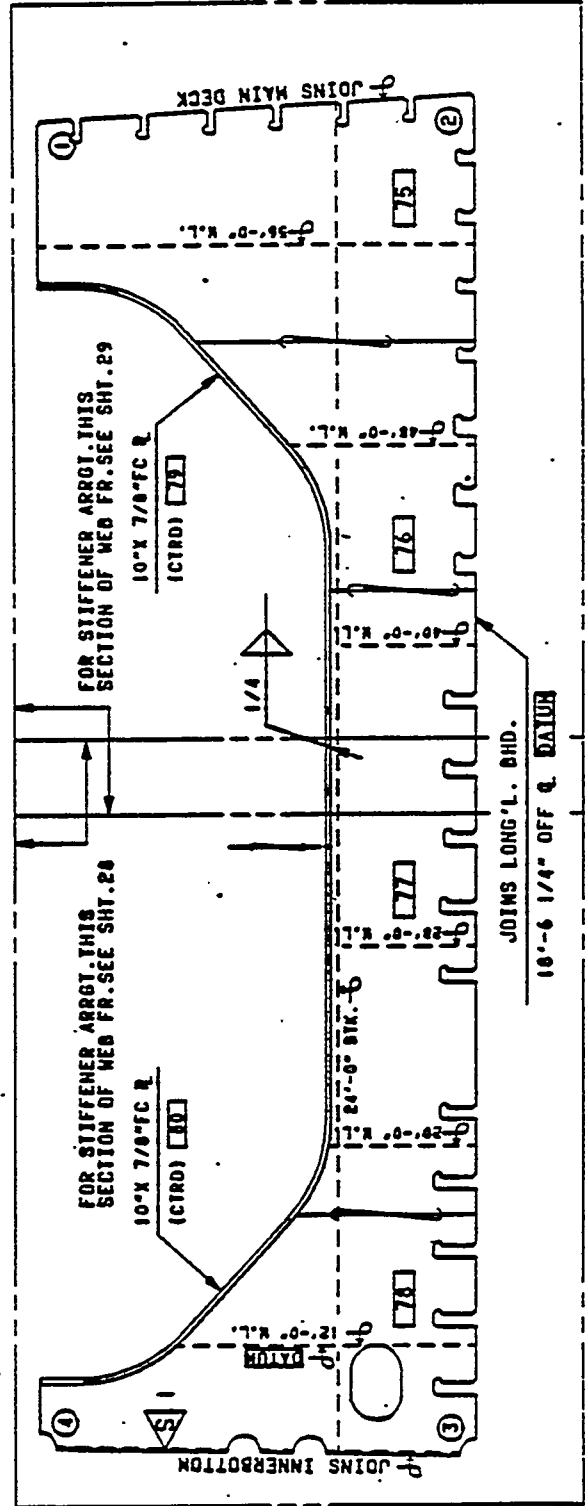


PARTS LIST				PARTS LIST				PARTS LIST			
LN	PIECE NO.	QTY	MATERIAL	LN	PIECE NO.	QTY	MATERIAL	LN	PIECE NO.	QTY	MATERIAL
1	43-1-2-40	1	1/2" PLATE	6	43-1-2-34	1	1/2" X 6" FB	11	43-1-2-39	1	1/2" X 6" FB
2	43-1-2-41	1	1/2" PLATE	7	43-1-2-35	1	1/2" X 6" FB	12	43-1-2-45	1	1/2" X 6" FB
3	43-1-2-31	1	1/2" X 6" FB	8	43-1-2-36	1	1/2" X 6" FB	13	43-1-2-25	1	1" X 13" PLATE
4	43-1-2-32	1	1/2" X 6" FB	9	43-1-2-37	2	1/2" X 6" FB	14	43-1-2-26	1	1" X 13" PLATE
5	43-1-2-33	1	1/2" X 6" FB	10	43-1-2-38	2	1/2" X 6" FB	15			

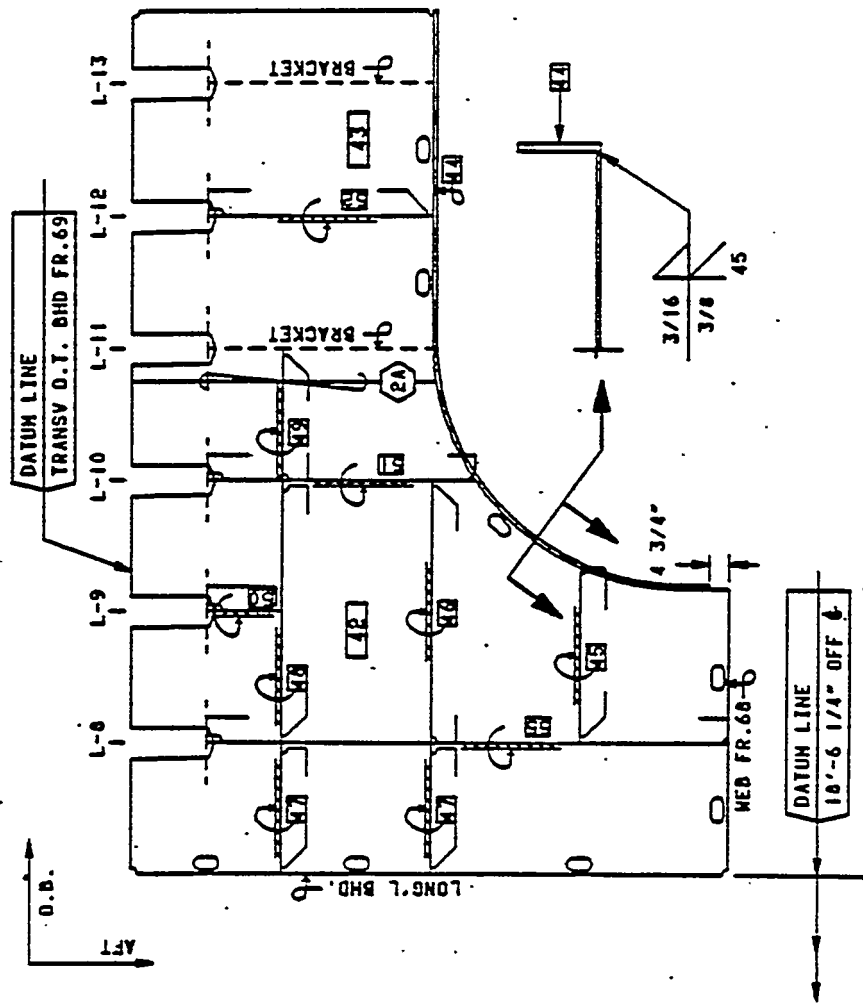


41-59,78	Multipl. 1,07576	SIZE B	TYP WELD	DRAWN BY A. HURLEY	JOB C1-15	PLATING ARRANGEMENT HORIZONTAL GIRDER #2	ASI DWG NO
041-23	122-68	0		CHECKED BY	REVISION	24'-3" ABL (FOR STIFFENER ARROT. SEE SHEETS 4A, 4B, & 4C)	PSIJ 43-1-2
							SH NO 4

0.8.  up

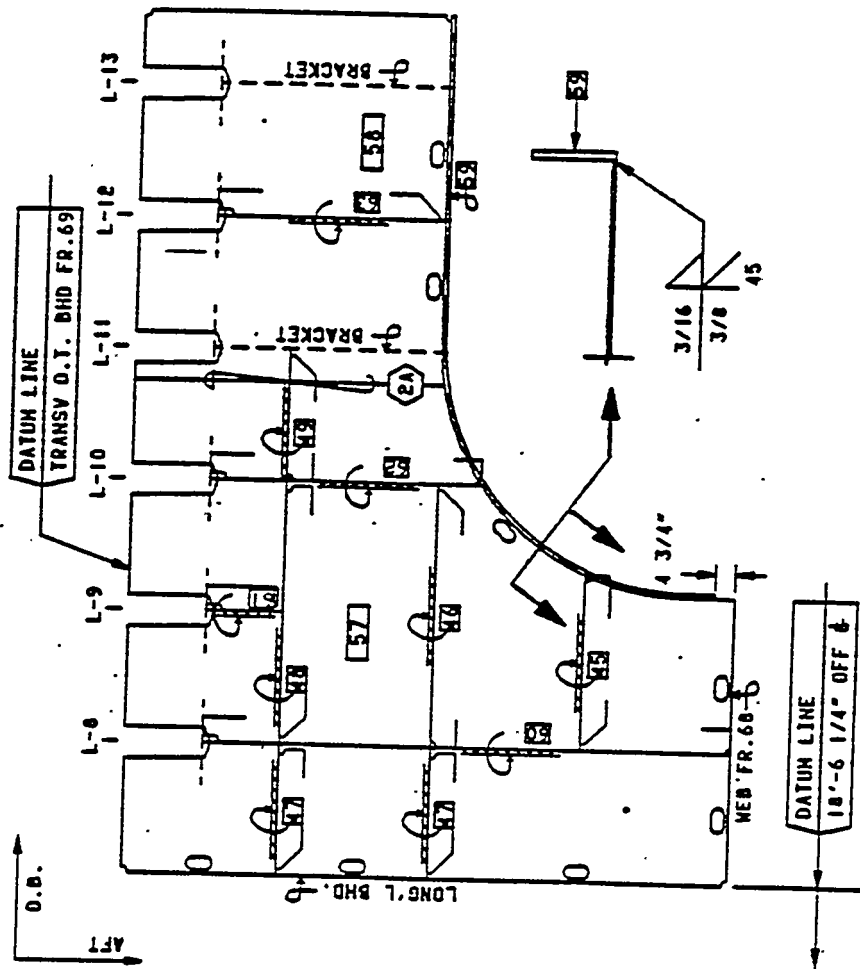


TYP WELD	SIZE	DRAWN BY	JOB C1-15	PLAYING ARRANGEMENT & A.C. DIMENSIONS OF WEB FR.68.	ASI DNG NO
2A	B	C. CUBRANY	REVISION		PSU 32-3-26
		CHECKED BY			
		W. H. HARRIS			SH NO 27
				CONTINUED ON SH NO 28	



PARTS LIST				
LM	PIECE NO.	QTY	MATERIAL	GRADE
	132-2-3-42	1	1/2" PLATE	AH-32
	132-2-3-43	1	1/2" PLATE	AH-32
	132-2-3-44	1	1" PLATE	AH-32
	132-2-3-45	1	1/2 X 6 F.B.	A-36
	132-2-3-46	1	1/2 X 6 F.B.	A-36
	132-2-3-47	2	1/2 X 6 F.B.	A-36
	132-2-3-48	1	1/2 X 6 F.B.	A-36
	132-2-3-49	1	1/2 X 6 F.B.	A-36
	132-2-3-50	1	1/2 X 6 F.B.	A-36
	132-2-3-51	1	1/2 X 6 F.B.	A-36
	132-2-3-52	1	1/2 X 6 F.B.	A-36
	132-2-3-55	1	1/2 X 6 F.B.	A-36

TYP	WELD	SIZE	DRAWN BY	JOB	CI-15	PLATING & STIFFENER ARRGT. OF HORIZ. GDR. 12'-3" ABOVE DATUM.	ASI DWG NO
5/16		B	C. BURGAMY	REVISION			PSU 32-2-3
3/16			CHECKED BY				SH NO 4



PARTS LIST				
LN	PIECE NO.	QTY	MATERIAL	GRADE
1	32-2-6-57	1	1/2" PLATE	AH-32
2	32-2-6-58	1	1/2" PLATE	AH-32
3	32-2-6-59	1	1" PLATE	AH-32
4	32-2-6-45	1	1/2 X 6 F.B.	A-36
5	32-2-6-46	1	1/2 X 6 F.B.	A-36
6	32-2-6-47	2	1/2 X 6 F.B.	A-36
7	32-2-6-48	1	1/2 X 6 F.B.	A-36
8	32-2-6-49	1	1/2 X 6 F.B.	A-36
9	32-2-6-60	1	1/2 X 6 F.B.	A-36
10	32-2-6-61	1	1/2 X 6 F.B.	A-36
11	32-2-6-62	1	1/2 X 6 F.B.	A-36
12	32-2-6-63	1	1/2 X 6 F.B.	A-36

TYP	WELD	SIZE	DRAWN BY	JOB	C1-15	PLATING & STIFFENER ARRGT. OF HORIZ. GOR. 28'-9" ABOVE DATUM.	ASI DHG NO
5/16		B	C. BURGANY	REVISION			PSU 32-2-6
3/8			CHECKED BY				SH NO 8



Test no. Wire ϕ Type of Wire

Section B

Section A

Average Pore area.

Vers.- Nr.	Draht- ϕ [mm]	Draht- sorte	I_a [A]	U_a [V]	v_a [cm/min]	CO ₂ [l/min]	coated		uncoated		Grundplatte besch. [μm]	a-Maß [mm]	mittlere Poren- fläche [%]
							Stegblech besch. [μm]	besch., unbesch.	Stegblech besch. [μm]	besch., unbesch.			
12	1,0	solid wire A	230	30	35	10	45			x	4,5	>10	
20	1,0	"	260	30	30	10		x	25		4,5	3,5	
31	1,0	"	235	27	33	10		x	25		5	4,4	
35	1,2	"	260	30	40	10		x		x	4,5	-	
28	1,2	SG 2	250	26,5	32	12	45			x	4,5	>10	
29	1,2	"	250	27,5	32	12		x	25		4	2,9	
30	1,2	"	250	27,5	25	12		x	25		5	2,6	
36	1,2	"	305	31,5	50	12		x		x	4,5	-	
22	1,2	cored wire B	340	30,5	44	12	45			x	4,5	>10	
32	1,2	"	340	30	42	12		x	25		5	6,5	
39	1,2	"	290	30	38	12		x	25		4,5	8	
34			360	34	50	12		x		x	4,5	-	
24	1,6	cored wire C	280	29	48			x	25		3	5,5	
26	1,6	"	280	29	34			x	25		4,5	3,4	
27	1,6	"	280	29	24			x	25		5	<1	
37	1,6	"	300	32	50			x		x	4	<1	

Literatur:

- /1/ N. N.: DAST-Richtlinie 006:
Oberschweißen von Fertigungsbeschichtungen
(FB) im Stahlbau
Deutscher Ausschuß für Stahlbau, Januar 1980
Stahlbau-Verlags GmbH, Köln
- /2/ N. N.: Germanischer Lloyd: Kapitel 7A-Schiffbau-
Schweißvorschriften
Abschnitt 6 - Oberschweißbare Fertigungsbe-
schichtungen
- /3/ N. N.: Richtlinie DVS 0501 (März 1976)
Prüfen der Poreneigung beim Oberschweißen von
Fertigungsbeschichtungen (FB) auf Stahl
Deutscher Verband für Schweißtechnik e. V.,
Düsseldorf
- /4/ Otto. J.: Beitrag zur Schweißgutbeeinflussung durch das
Oberschweißen von Fertigungsbeschichtungen
Dr.-Ing. Dissertation, Ruhr Universität,
Bochum, 1978

This Code of Practice has been drawn up by the Deutsche Ausschuss für Stahlbau (DAST) and the Deutsche Verband für Schweißtechnik (DVS) by arrangement with the Institut für Bautechnik (IfBt) Berlin. It replaces the edition of June 1969. Practical experiences with this Code of Practice to be reported, please, to DAST, Ebertplatz 1, 5000 Cologne 1.

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1 General

1.1. Scope

This Code of Practice relates to the overwelding of shop primers on load-bearing steel components with predominantly static loading and with not predominantly static loading.

1.2 Object of this Code of Practice

This Code of practice regulates

- * the quality assurance of shop primer materials
- * their application and
- * the overwelding of shop primers whilst maintaining given limit values for permissible pore areas in the weld.

1.3 Related standards, regulations and codes of practice

DIN 1030 Steel structures; construction

DIN 4130 Welded structural steelwork with predominantly static loading
Supplementary Sheet 1

DIN 4131 Welded steel road bridges. Design and structural details

DIN 18 802 Part 1: Design and construction

Part 6: Design and construction for not predominantly static loading¹⁾

DIN 55 928 Protection of steel structures from corrosion by organic and metallic coatings

Part 1: General

Part 4: Preparation and testing of surfaces

Part 5: Coating materials and systems protecting from corrosion

Part 8: Corrosion protection of supporting thin-walled components (light-gauge steel construction)²⁾

Part 9: Binders and pigments for coating materials²⁾

DS 804 Regulations for railway bridges and other civil engineering works (German Federal Railways)

DVS-Code of Testing of the tendency towards pore formation practice 0501 in the overwelding of shop primers on steel.

1) under revision

2) in preparation

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